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THE USE OF THE ANTENNÆ IN INSECTS.

BY L. TROUVELOT.

IT has been a question among naturalists whether the antennæ of insects were organs of touch, hearing, or smell. Notwithstanding the progress of science, our knowledge of this subject does not seem to have much advanced. While some naturalists, such as Blainville and Latreille, place the sense of smell in the antennæ, others, such as Hentz, Baster, Lehrmann, Dumeril, and Cuvier, refer it to the spiracles, Huber to the mouth, and Humboldt to different parts of the body. In a recent publication I see it stated that the antennæ are a great deal more complex than formerly supposed, and probably unite the functions of touch, hearing, and taste.

In view of this great divergence of opinion it occurred to me many years ago that experimentation would throw some light upon this subject, and I therefore began a series of experiments which I will here record.

I procured fifty or sixty living butterflies of *Limenitis Disippus* Godt. I had seen it stated that "Dr. Clemens having deprived butterflies of their antennæ, and having thrown them up, had observed that they could not fly, and fell heavily down without opening their wings." 1. I first repeated this experiment with about a dozen individuals, all of whom, without exception, took flight, but I could observe a certain hesitation in the flight which gave less boldness and accuracy to their movements.

2. I then prepared some very thick Indian ink, and with a brush I covered carefully the eyes of several individuals, and waited until the opaque body was perfectly dried before experimenting. I let one and then another go free; they could fly, and strange as it might seem, though perfectly blind, in no case did one go blindly and hurt itself by flying against anything hard, but on the contrary they seemed to have a knowledge of the proximity of these objects, and in some cases would turn away and rest upon

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some other thing. But it was noticeable that before resting, the insect acted exactly the same as uninjured individuals out-of-doors, by moving its wings, poising itself for a moment in the air in front of the object on which it had chosen to rest. A proof that the insect was perfectly blind and could not see is the fact that none of those which had their eyes covered with Indian ink were observed to fly to the single window giving light to the room where the experiments were made; if they had seen but slightly, they would have flown to the light, as all insects do in similar cases.

3. With one of these insects deprived of light I made, with a pair of scissors, and close to the head, a section of both antennæ. This insect when thrown up fell heavily down, sometimes not opening its wings at all, and was entirely unable to direct its flight.

4. I made another butterfly blind, and removed the antennæ, as in Experiment 3, and placed it at liberty upon a table, allowing it to rest a few minutes. I prepared a solution of sugar and water, and with a small brush I took up a drop of the sweet liquid, and then slowly and carefully I moved the brush very near the mouth, the head, and the spiracles, in fact all around the body. The poor blind butterfly remained perfectly still; no emanations whatever seemed to reach it from so sweet a substance. Then, guided by induction, I touched the stumps of the cut antennæ; no sooner was this done than it received the impression, unrolled its proboscis, and with great activity searched for the sweet object, in order to realize the impression it had received. For two or three minutes it was actively employed in the search, when I put before it a drop of the sweet beverage which it soon found and drank.

5. Taking another butterfly, prepared like the above, I placed on each stump of the antennæ a very small drop of thick gum arabic, and waited until it dried. This insect, thus prepared, when thrown up seemed to be without sensation, falling down like a stone, without any motion of the wings. As with the preceding butterfly, I placed it upon a table, and held the brush with the drop of sugar-water and let it touch the sealed antennal stump, but no impression was received. I also pressed the brush on the proboscis, but it was not until I had pressed so hard as to wet it through that it felt the impression and unrolled its tongue.

The following summer I made some fresh experiments upon this interesting subject. Of all the Lepidoptera with which I

am familiar in this country, the Promethea silk-worm moth is the one which in confinement will most readily accomplish the act of copulation. I have not yet found that a virgin pair on being put together did not unite the following afternoon.

6. I took several virgin pairs of this species (*Callosamia Promethea*), put each pair in a separate box, and let them remain together until they died. Each male had been deprived of its antennæ. I collected the eggs carefully; without an exception they were unfertilized, sexual union not having taken place.

Since making these experiments, it occurred to my mind that it might be objected that by cutting off the antennæ of an insect the pain resulting from such a wound would sufficiently explain the failure of a congress of the sexes. I have many times observed the sexual union of insects with one or two legs wanting, with wings half broken, etc. So, last summer, in order to test the value of this objection, I procured a certain number of virgin Promethea just out of the cocoon, and mutilated the males in different ways, some by cutting off a piece of the wings, others by the removal of a leg. These mutilated males were put with the virgin females, but notwithstanding their wounds union took place, and I raised young worms from the eggs laid by the females.

7. One afternoon I was sitting upon a rock under the shade of a tree, when my attention was attracted to a procession of a large species of ant, going from the nest to a considerable distance to gather, I think, some article of food. I contemplated in silence for some time the efforts of these industrious little laborers, when an idea crossed my mind that I had an opportunity to make one more experiment upon the use of the antennæ. I caught two or three of them, and with a small pair of scissors cut off the antennæ, and then I let them go free by the side of their busy comrades. But it was of no use; they did not seem to recognize their brothers, and did not follow the same path, but would trace a circle and turn about in every direction as if to find the route they were following before, not seeing that they had crossed it hundreds of times, and that their friends were following that same route; their eyesight was not sufficient to enable them to discover their way. After observing them for more than an hour, I found that they had not gone out of this circle when I left them.

From the second experiment I infer that when deprived of sight, insects fly with less boldness and accuracy, but they do not

blindly fly against objects, being apparently aware of their proximity. Here the faculty of sight is only an adjunct to the sense which resides in the antennæ.

In insects subjected to the first experiment, though having the power of sight, flight is deficient, the antennal sense is wanting to help the sight, and when the eyes and antennæ are rendered useless the insect is totally unable to direct its flight or to find its food. The compound eyes of insects do not seem to enable the insect to see objects at a distance, so vision is aided by another sense which has the antennæ as its organ.

In the sixth experiment the male Promethea had his sight; he could see near him another insect like himself, but his eyes alone could not tell him whether the insect was of the same species and of another sex, so he died near the object he would have desired with so much ardor if the sense organs which would have enabled him to detect the presence of the object had not been removed. So it was in the seventh experiment; the ant could see the others going on their way so intelligently, but with its eyes alone it could not recognize its friends; all were mute to him, and in the midst of friends he seemed to be in a desert.

Were I to draw any conclusion from these experiments I would say that the sense localized in the antennæ cannot be regarded only as that of touch, hearing, or taste, nor can it be regarded as uniting their complex functions. In no case have I observed insects using the antennæ as feelers; it is true they move them very rapidly when they want to recognize an object, but very seldom do the antennæ come in contact with the object; if they are feelers, they feel at a distance. With more reason they should be regarded as organs of smell, but if their functions have some analogy with the sense of smell, I think they must be very different from the sense of smell in the human species, and I would venture to say that it might have some analogy with the sense so little known though so common among animals, — with the horse, for instance, — which enables it if removed not to retrace, but find a straight line to its home, from a considerable distance, and with as much accuracy as if it could see it. So in my opinion this sense, being different from the senses common to the human species, needs a new name so as to be distinguished from and not confounded with the sense of smell. It is a kind of feeling or smelling at a great distance, by some process now totally unknown.

ABORIGINAL FUNEREAL CUSTOMS IN THE UNITED STATES.

BY EDWIN A. BARBER.

RESPECT for the dead, evinced by ceremonies, rites, or solemn decorations, has been universal in all ages and all countries. Much information can be gleaned, as to the practices of prehistoric man, from the construction of graves [1] and the relics obtained therefrom. The paleolithic and neolithic stone tools, and the later copper and bronze instruments, remain intact for centuries; but iron rusts and rapidly crumbles away, while wood decays, and all other remains of the iron age vanish in a few years, often before the particles of the human frame-work have become disintegrated. More, therefore, can be learned relative to the modes of sepulture of the ancients than the methods of burial of much more recent tribes, and we are frequently compelled to draw conclusions in regard to the customs employed by the Indians of a century or so ago from the usages of their ancestry, since it is a well-established fact that these are handed down from generation to generation, with but few, if any, improvements or modifications. Comparatively little is known of the funereal rites of our modern savages, when we consider the great number of tribes; a fact explained by their distant removal from the centre of civilization, the secrecy of their ceremonies, and the superstition of the savage mind in regard to death. Strangers are seldom permitted to witness the disposition of Indian bodies, and nearly all such information has been obtained from subsequent grave-desecration. So far as our present knowledge extends, as regards aboriginal burial in the United States, there were four methods, namely: —

I. By inhumation (subterrene).
II. By cremation (subterrene).
III. By embalmment (subterenne).
IV. By aerial sepulture (superterrene).

The first was the one usually employed.

Bodies were interred either in ordinary graves, in mounds, or in caves. The ancient Pueblos of the Pacific slope generally practiced grave-burial. The corpse was placed three or four feet beneath the surface of the earth, and at its head were arranged food vases, ornaments, and implements of the chase. The

[1] The word *graves* in this paper is used in its broadest acceptation, including *all* places of deposit for dead bodies.

surface of the grave was level with the surrounding ground, and its dimensions were defined by stones set on edge in the soil, forming a parallelogram five or six feet in length and from two to four in breadth. The ragged edges of the slabs projected above the surface from six inches to eighteen, and occasionally a head-stone reached to the height of two feet. On none of the latter, however, has an inscription of any kind ever been observed differing in this respect from the wooden *adjedatiys* of the Dakotas.

Many interesting graves have been discovered and examined throughout the Cañon of the Rio-Mancos, in Southwestern Colorado. Captain John Moss, of that State, unearthed from one of these a perfect skull and some fragments of other bones of a human skeleton. From another he took several entire and curiously shaped vessels of pottery,[1] now in possession of Hayden's United States Geological Survey of the Territories, at Washington. It would appear from this that the deceased were supplied with vessels of food and drink to assist them on their journey to the mysterious hereafter. In addition to this custom, great quantities of pottery were strewn or broken over the surfaces of graves, in honor of the departed. Occasionally large vases or other vessels are found in a state of tolerable preservation, or, indeed, entire; these had been placed there by the friends of the deceased; but whether they were originally full of food, it is difficult to determine. In the neighborhood of Aztec Springs are long series of graves extending for miles along the valley west of the great Mesa Verde. In a particular spot, an arroyo has cut through one of these graves, showing a vertical section of it. About four feet from the level of the valley a quantity of broken pottery and charred wood may yet be seen, — the former probably at one time constituting perfect food vessels, — arranged at the head of the corpse; but the skeleton had disappeared after the exposure of many years.

Near the beginning of the Cañon of the Hovenweep, a skeleton was seen partially protruding from the eastern bank of this arroyo. It was lying about three feet below the surface, the face pointing eastward, the back of the skull only being visible. On removing it from the bank the skull fell to pieces, and but two or three of the long bones could be found, the rest of the skeleton having crumbled to dust. Sage-brush (*Artemisia*), was growing over the grave, indicating a growth of at least a hundred

[1] See Figure 12, Pl. ix., American Naturalist for August, 1876.

years, and the skeleton must have been placed there long before the vegetation commenced.

Several ancient skeletons were exhumed in the Cañon of the Montezuma in Southeastern Utah, where great numbers of graves were found. In one tomb was a portion of a skeleton, including the long bones and some of the phalanges. The skull had entirely disappeared. From another grave we took a well-preserved skull and other portions of the skeleton, all of which have been removed to Washington. This latter skull, however, is probably that of a modern Navajo. Along the valley of the Rio San Juan lies one of the most extensive aboriginal cemeteries. The graves continue uninterruptedly for several miles, and thousands of subjects were evidently here buried. The only traces of buildings are some low, circular mounds, about fifty feet in diameter, indicating the former existence of adobe structures, over which occur great quantities of broken pottery and a number of arrow-points.

Several tribes were accustomed to incase their dead in stone boxes or tombs. Among these were the Lenni Lenape, or Delawares, of Pennsylvania, although the graves already opened show an antiquity of probably not more than one hundred and fifty or two hundred years, because the native contents, consisting of fragments of rude pottery and ornaments, are associated usually with articles of European manufacture, such as glass beads, iron or copper implements, and portions of fire-arms. A number of graves have been examined in the vicinity of the Delaware Water Gap. The tumuli were scarcely distinguishable, but were surrounded by traces of shallow trenches. The skeletons lay at a depth of about three feet, and were in almost every instance inclosed in rude stone coffins. In one case the body had been placed in a slight excavation, facing the east, and above it a low mound had been built.

The second variety of inhumation was *tumulus burial*. This prevailed to a great extent among the mound builders of the Mississippi Valley. In some instances a mound contained but one body, while in others it constituted a general burial ground. The dead were generally near the original level of the surface and the mounds heaped over them. No particular posture of the body was assumed; sometimes it reclined; occasionally it was sitting, but most frequently it was extended on the back. The face was often pointed eastward, though no general rule was observed in respect to orientation.

A third method of inhumation was cave burial, such as was employed by the troglodytes of the Vézère, in Southern France. This was not common in the United States, though isolated instances are recorded, such as the remains found in the deposits of a cave in Breckenridge County, Kentucky, and also in caverns through the cañons of Utah, Arizona, and New Mexico.

Cremation was of two kinds: in graves and in urns. The former was practiced, to some extent, by the ancient Pueblos of Arizona and Utah. The body was burned and the ashes deposited in shallow tombs, marked in the ordinary way by slabs of stone set on edge around the spot. Several tribes of the Rio Gila [1] in Southern Arizona and some in Texas were in the habit of burying the bones of their departed in urns. Sometimes the skull was placed face downwards in the mouth of the vase, and served as a sort of cover or lid. In the immense cave town on the Rio de Chelly (examined by a portion of Hayden's United States Geological Survey), seven burial urns were unearthed, which had been placed in a group, their edges touching. They had been hidden just below the surface soil, on a mound of earth at the foot of the walls of the pueblo. Removing them carefully from their positions, it was found that they were about fifteen inches in height, six or seven across the mouth, made of coarse, sandy clay, and burned to a sooty blackness. The vessels were filled to the mouth with some substance, which, on examination, proved to be a white adobe cement, below which appeared fragments of charcoal, burned corn cobs, and small pieces of highly glazed pottery. No indications of charred bones were found in them, however, and it could not be determined satisfactorily whether they had originally contained sacrificial offerings merely, or whether they held human remains. At the foot of the village an extensive grave-yard was discovered, marked off into square and circular tombs by the usual upright stones. A few hundred yards beyond this, up the stream, was another extensive place of interment; so that while the latter was the usual mode of burial, it would seem as though cremation had been resorted to by the people, while the enemy was attacking the town; for it is evident that there had been a great and bloody fight here, which can be proved by the quantity of arrow points and numerous other indi cations.

[1] The Spaniards, as late as the sixteenth century, found some tribes in this portion of the West, which cremated their dead. Captain Fernando Alarcon, in an account of his expedition in 1540, mentions a people near the Colorado River which lived in great houses of stone and burned their corpses.

It is a matter of certainty that cremation was performed without urns; that is, bodies were burned in graves or stone tombs. At the junction of the two dry arroyos, the McElmo and the Hovenweep, a considerable community once existed. On the point of a high mesa, overlooking the water-courses for many miles to the north and south, a large burial ground was discovered, marked off by upright stones, the longest being always at the head of the grave. On opening several of these with pick and shovel, it was found that the solid bed-rock appeared at a depth of six inches to a foot and a half, so that it was impossible to have here buried any natural human bodies. It was found, on further investigation, that in each one was a quantity of black dust and some fine white powder. The majority of these graves were rectangular, but among the rest were two or three large circular *mounds*, about twenty feet each in diameter, where had probably been laid the ashes of persons of note or greater wealth. In Southwestern Colorado, the valley northeast of Ute Mountain was covered with these square inclosures, among which could be traced the foundation mounds of very ancient abodes, which had been constructed, for the most part, of clay. Among these graves we spent an entire morning, but were rewarded by the discovery of nothing except layers of fine white dust and some small fragments of burnt wood. The graves were very old, and it seemed not strange that a thousand or more years had destroyed nearly all traces of their former contents. And so in the immediate neighborhood of every considerable pueblo, we found graves more or less numerous.

From the Alta California I extract the following account as given by Mr. J. A. Parker, Superintendent of the Montezuma Canal Company of Southwestern Arizona. In speaking of the ancient ruins and human remains of Pueblo Viejo Valley, he says, "The human bones show unmistakable evidence of having been burned, and crumbled to pieces upon being handled. Several ollas (pronounced *ó-yahs*) — jug-shaped, earthern vessels, now used by the Indians for holding water — were found, which contained ashes, *small pieces of human bones*, and fragments of charcoal, which would indicate that cremation was practiced by that extinct people."

Prof. John L. LeConte describes the ceremony of cremation as performed by the Cocopa Indians of the Rio Gila, and witnessed by him in the year 1850: "A short distance from the collection of thatched huts which composed the village a shallow

trench had been dug in the desert, in which were laid logs of the mesquite (Prosopis and Strombocarpus), hard and dense wood, which makes, as all western campaigners know, a very hot fire with little flame or smoke. After a short time the body was brought from the village, surrounded by the family and other inhabitants, and laid on the logs in the trench The relatives, as is usual with Indians, had their faces disfigured with black paint, and the females, as is the custom with other savages, made very loud exclamations of grief mingled with what might be supposed to be funeral songs. Some smaller fagots were then placed on top, a few of the personal effects of the dead man added, and fire applied. After a time a dense mass of dark-colored smoke arose, and the burning of the body, which was much emaciated, proceeded rapidly. I began to be rather tired of the spectacle and was about to go away, when one of the Indians, in a few words of Spanish, told me to remain, that there was yet something to be seen.

"An old man then advanced from the assemblage with a long, pointed stick in his hand. Going near to the burning body he removed the eyes, holding them successively on the point of the stick, in the direction of the sun, with his face turned towards that luminary, repeating at the same time some words which I understood from our guide was a prayer for the happiness of the soul of the deceased. After this more fagots were heaped on the fire, which was kept up for perhaps three or four hours longer. I did not remain, as there was nothing more of interest, but I learned on inquiry that after the fire was burnt out it was the custom to collect the fragments of bone which remained, and put them in a terra-cotta vase, which was kept under the care of the family."[1]

But few cases of embalming are known to have occurred in the limits of the United States. As examples of this mode of preparing the corpse may be mentioned the Mammoth Cave and Salt Cave mummies of Kentucky. These bodies had been preserved by a rude species of embalmment and by exsiccation.

Aerial sepulture included all burial which was performed above the surface, and consisted of two kinds: the first by suspension on scaffolds or in trees, the second by sepulture in canoes. Several tribes still employ the former mode of burial. The Sioux elevate the bodies of their friends into trees, or stretch them

[1] Proceedings of the American Association for the Advancement of Science, 1874, page 41.

out on raised platforms, wrapping them in blankets and leaving them to the mercies of the elements and carnivorous birds.

Lieut. J. W. Abert tells us, in his Notes of a Military Reconnoissance in 1846, that he saw in the Arkansas bottom "several Indian bodies wrapped in blankets and skins, exposed on platforms of lodge poles, high up in cotton-wood trees, where they are safe from wolves and the sacrilegious touch of men. The air of the prairie produces rapid desiccation, and in this respect resembles Egypt and the islands of the ancient Guanches." Canoe burial is resorted to by several tribes of the Northwest. Mr. John K. Townsend, in his narrative of a journey across the Rocky Mountains, describes several such burial grounds. One, at Mount Coffin, consisted of a great number of canoes containing bodies of Indians, each being carefully wrapped in blankets, and supplied with many of his personal effects in the form of weapons and implements. Near the Columbia River was found another cemetery of this sort. The bodies were lying in canoes which had been elevated five or six feet into trees or placed on stakes. In some instances the corpses "were nailed in boxes or covered by a small canoe, which was turned bottom upwards and placed in a larger one, and the whole covered by strips of bark carefully arranged over them.

"The corpses of the several different tribes which are buried here are known by the difference in the structure of their canoes, and the *sarcophagi* of the chiefs from those of the common people by the greater care which has been manifested in the arrangement of the tomb."

Mr. Townsend also mentions another method which some of these tribes occasionally employed: "We observed to-day several high, conical stacks of drift-wood near the river. These are the graves of the Indians. Some of the cemeteries are of considerable extent, and probably contain a great number of bodies." These tombs should in all likelihood be classed with tumuli or burial mounds.

Washington Irving describes some of the same burial grounds in his Astoria, but his descriptions do not differ materially from those of Mr. Townsend.

In the Sandwich Islands, Mr. Townsend informs us, the natives practiced another mode of burial which was partially *aquatic*. Similar to a sacrificial altar, they construct what is called a *morai*. "It was the place to which the bodies of the dead chiefs were carried previous to interment. After lying here in state for a

longer or shorter time, according to the grade of rank held by the deceased, the flesh was stripped from the bones and buried in the sea; the bones were then taken and deposited in caves or subterranean vaults, which concluded the ceremony."

Aquatic burial, so far as we yet know, was not resorted to in the United States save in exceptional instances.

In regard to the Indians previously alluded to, who disposed of their dead on Mount Coffin, Mr. Irving remarks: "The same provident care for the deceased that prevails among the hunting tribes of the prairies is observable among the piscatory tribes of the rivers and sea-coast. Among the former the favorite horse of the hunter is buried with him in the same funereal mound, and his bow and arrows are laid by his side that he may be perfectly equipped for the "happy hunting grounds' of the land of spirits. Among the latter the Indian is wrapped in his mantle of skins, laid in his canoe with his paddle, his fishing-spear, and other implements beside him, and placed aloft on some rock or eminence overlooking the river, or bay, or lake that he has frequented. He is fitted out to launch away upon those placid streams and sunny lakes stocked with all kinds of fish and waterfowl, which are prepared in the next world for those who have acquitted themselves as good sons, good fathers, good husbands, and, above all, good fishermen during their mortal sojourn."

In conclusion I would state that I have simply aimed in this paper to briefly review the different forms of sepulture of the past and present aboriginal inhabitants of the United States. The article is not intended to be exhaustive, as the subject is one which would fill several volumes were it properly treated. The examples I have selected are mostly such as are comparatively new or have not as yet attracted general attention. The graves of the ancient Pueblos of the western slope have never, I believe, been accurately described.

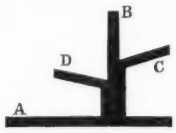
THE SLEDGE MICROTOME.

BY CHARLES SEDGWICK MINOT.

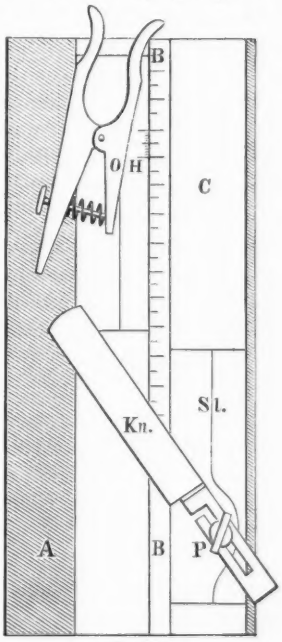
THE preparation of microscopical sections by free-hand cutting, or even with the assistance of the microtomes now in use, is accompanied by great difficulty in producing sections of even thickness. In all cases the chief trouble is caused by the irregular motion of the knife or razor which is held in the hand, and

microscopists acquire skill in cutting only by tedious practice, involving a vexatious loss of time. The instrument it is proposed to describe was invented by a French botanist to avoid this difficulty by making the guidance of the knife entirely dependent upon a mechanical construction. The instrument is so simple that two or three days suffice for learning to make sections of any desired thickness with it, while it may be used with such rapidity that hundreds of sections, all equally good, may be made in a single morning.

The instrument is made of brass, and consists of a flat, oblong base and a vertical partition (Figures 25 and 26, *B*) rising from it and running lengthwise. On each side of this partition there is a platform, that on the right-hand side (*C*) runs horizontally along the partition, and there is a sledge made to slide on it. The platform on the left-hand side (*D*) begins at one end of the partition, quite low down (Figure 25), and rises slightly but continuously as it runs along to the other end of the partition, Figure 26 (*B'*). This platform carries a sledge furnished with a clamp to hold the object to be cut. Both the platforms are oblique, as may be seen in Figure 25, so as to form together with the partition a sort of groove which is sufficient to guide the motion of the sledges perfectly. The principle of the instrument is, that the object is shoved up an inclined plane on the left-hand side, and is thereby raised. Then the knife, fastened to the sledge on the right-hand platform, is drawn back, and cuts through the object, which is then shoved a little further up the inclined plane, and the knife when drawn across cuts again in a plane parallel to that of the first cut, and thus a slice with two parallel surfaces is removed. Of course the thickness of the section is determined by



(Fig. 25.)
End view, ½, without the sledges.



(Fig. 26.)
View from above, ½.

the distance the object is moved up the inclined platform between the first and second cuts.

Figure 26 represents the microtome as seen from above, one half the natural size. *A*, which is shaded, represents the base; *BB'* is the top of the partition, and is marked off into millimeters, though only the centimeters are represented in the cut; on the right is the horizontal platform *C*, while the sledge (*Sl*) is represented lying on it; the sledge is provided with a screw pin (*P*) for fastening the knife, the handle of which is provided with a slot into which the pin may be slipped; the knife (*Kn*) is placed obliquely, as seen in the figure, so as to project over the other side of the partition. The sledge is made so high that the knife lies above the top of the partition. On the left-hand side of the partition is the inclined platform *D*, carrying the sledge or object holder *OH*. This carries a clamp shaped very much like one of the patent clothes-pins now so much in vogue for hanging up maps and diagrams. The object to be cut must be imbedded in paraffine or soap; it is then placed between the front arms of the clamp, where it is held tightly by the action of a spiral spring between the hind arms (compare Figure 26), so arranged as to press the front arms together.

The object holder must be slid down and the knife sledge pushed forward, and the first cut may be made by pulling the knife back. After making the cut the object is again shoved up the inclined platform a little way; the exact distance may be determined by means of the scale on the top of the partition *BB'*. The inclination of the platform is such that the slice cut off is in thickness one twentieth of the distance which the object has been shoved forward, that is, the rise is one in twenty, so that if the object be moved forward 1 m.m. the section will be $\frac{1}{20}$ m.m., and so on.

No sooner has one section been cut off than another may be made, which will be exactly parallel to the first. In this way a long object can be cut into very thin sections, all equally good, and exhibiting every part of the body cut. Now, suppose a small worm to be cut in this way into transverse sections, we could examine first the head and then the successive portions of the body. I have frequently made long series of such sections, and have found them to afford a surer means of studying the anatomy of minute opaque animals than any other I know of, for in this way every portion of the animal may be subjected to minute examination, and, further, the sections once made and mounted they

may be stowed away and investigated at any leisure moment. For example, during a few weeks at the seaside, material for a winter's occupation may be very easily procured. Neither is there so much hurry in drawing, as when an animal is living we are afraid it may die. For the sake of controlling the observations made on the sections, sketches of the general structure may be made, thus enabling the student to remember where each particular section must have come from.

There, is however, one other consideration to be noted, namely, that every cut destroys a certain amount of tissue. Thus suppose that a worm, as in Figure 27, be cut transversely, a good deal will be destroyed; but if longitudinal sections be made of another specimen, then one will see parts that the cut destroyed before, and only those spots where the two sets of cuts would have crossed had they been on the same animal will be wanting in both series. But even if you merely make a second series of cuts they will not destroy exactly the same place as in the first series.

(FIG. 27.) Longitudinal and transverse sections, the lines showing the cuts.

When only a few preparations of some tissue are wanted, this instrument permits a rapidity of work combined with a degree of nicety unattainable by any other means, and I do not hesitate to recommend it most highly both to those who are carrying on microscopical investigations and those who are forming amateur collections, for only a little care is requisite to enable even persons with unskillful or unpracticed hands to make preparations equal to the very best that have ever been produced.

To succeed in doing this, however, very great care must be paid to the way of preparing the object. The following method is applicable in a great many cases, in all, in fact, except where there is any fat to be preserved, or where, as is not unfrequently the case in histology, a special method of hardening or staining has to be employed: If the object is some small animal it may be killed by putting it in an 0.1% osmic-acid solution or in picric acid, and then in alcohol for twenty-four hours or less, according to the size of the object, and finally in absolute alcohol in sufficient quantity to entirely remove all the water from the object. For this purpose thirty or forty times the volume of the object is necessary. If the object is a bit of tissue or some organ it may be hardened in alcohol without any preliminary treatment. When the object is composed of loose tissue, and is not more than 3 m.m. in diameter, it may be colored *in toto*, thereby sav-

ing a great deal of labor. This is done by putting it after it has been in absolute alcohol in a very weak carmine or hæmatoxyline solution. Either of these may be prepared by diluting the ordinary tinctures (Beale's carmine or Bœhmer's hæmatoxyline) with about six times their volume of distilled water. Carmine usually gives the best results. The object must be left from twelve to twenty-four hours in the coloring solution, according to its size and nature, and then replaced in absolute alcohol for twenty-four hours.

It is sometimes convenient to use chromic acid for hardening tissues a little before putting them in the alcohol. In this case they cannot be easily colored *in toto* unless every trace of the chromic acid has been removed by frequently renewing the absolute alcohol, a troublesome process requiring a long time and large quantities of spirit.

The object once hardened, or colored and hardened, as the case may be, can be imbedded in paraffine by the following method: Place it in pure turpentine for half an hour, then five or ten minutes in a mixture of equal parts of paraffine and turpentine by weight, warmed so as to be liquid, and afterwards in pure, melted paraffine for five minutes. Great care must be taken not to have the paraffine warmer than is necessary to keep it liquid, otherwise the tissues will be ruined. The object should be moved about gently in the paraffine to free it from the turpentine adherent to its surface. By these processes the paraffine penetrates the whole object, giving it the best consistency possible for cutting.

The next step is to pour some paraffine into a little paper tray, then lay the object in it, and pour in enough paraffine to cover it over entirely, and leave it for half an hour or more to cool. The mass of paraffine, when solid, may be taken out, and trimmed down with a penknife to such a size and shape as will let it fit into the clamp of the object holder of the microtome; the part containing the object must project enough above the clamp to be struck by the knife as it is drawn along, in the way above described.

When the object contains fatty tissue which it is wished to examine more closely, it may be imbedded in the so-called transparent glycerine soap in the way that has already been in use for several years.

The sections when made are surrounded by paraffine, and usually curl up. They must be taken up with a fine-pointed brush,

barely moistened with spirits of turpentine, and then put on a slide and covered with a drop of turpentine, which dissolves in a few seconds all the paraffine. The sections can then be unrolled with the brush. If the object is colored *in toto*, the sections are all ready for mounting, which may be done by wiping off the superfluous turpentine with a bit of cambric. The addition of a drop of balsam (or better still of a mixture of one part Canada balsam and two parts white Dammar varnish) and putting on a cover slip complete the preparation.

If, however, the object has not been colored beforehand, the sections must be stained singly; to do this, when they have been imbedded in paraffine they must be left half an hour in a few cubic centimeters of spirits of turpentine, then one fourth of an hour in absolute alcohol, after which the alcohol should be renewed and the sections left for another quarter of an hour, whereupon they can be at once stained and mounted either in balsam or glycerine in the usual manner described in all hand-books of microscopy or histology.

This method of imbedding in paraffine has the great advantage that objects once prepared in this way may be kept indefinitely and be cut at any time, or even be partially cut, and then be stowed away to be cut again by and by, it being only necessary to cover up the exposed surface of the object by dropping a little melted paraffine upon it. I have a small collection of such objects, each one bearing a number referring to a catalogue, so that there are several things of which I can make a first-rate preparation in ten minutes at any time.

I have found it convenient in making long series of sections to designate each series by a letter of the alphabet, and after having been once through to begin anew AA, AB, AC, and then again BA, BB, BC, and so on, I am accustomed to put several sections on each slide, which are numbered. My catalogue shows what each series is, and also anything about any section I choose to note, thus: "W. Planaria tora, transverse sections, 2 (slide number) through the brain, III. (number of section) through the eyes. In this way any particular section out of many thousands can be quickly found.

The sledge microtome can be obtained of Thomas A. Upham, mechanician, 17 Harvard Place, Boston, Mass., for $25. The knives have, at present, to be imported from Windler, Dorotheenstrasse 3, Berlin C, where they cost 6 marks (2 thalers) apiece. But Mr. Upham hopes soon to be able to supply knives himself.

ON THE STUDY OF BIOLOGY.[1]

BY PROF. T. H. HUXLEY.

THE sense in which "natural history" was used at the time I am now speaking of has, to a certain extent, endured to the present day. There are now in existence, in some of our northern universities, chairs of civil and natural history, in which the term natural history is used to indicate exactly what Hobbes and Bacon meant by that term. There are others in which the unhappy incumbent of the chair of natural history is, or was, still supposed to cover the whole ground of geology and mineralogy, zoölogy, perhaps even botany, in his lectures. But as science made the marvelous progress which it did make at the end of the last and the beginning of the present century, thinking men began to discern that under this title of natural history there were included very heterogeneous constituents, — that, for example, geology and mineralogy were, in many respects, very different from botany and zoölogy; that a man might obtain an extensive knowledge of the structure and functions of plants and animals without having need to enter upon the study of geology and mineralogy, and *vice versa;* and further, as knowledge advanced, it became clear that there was a great analogy, a very close alliance, between those two sciences of botany and zoology which deal with living beings, while they are much more widely separated from all other studies. It is due to Buffon to remark that he clearly recognized this great fact. He says: "Ces deux genres d'êtres organisés (les animaux et les végétaux) ont beaucoup plus de propriétés communes que de différences réelles." Therefore it is not wonderful that at the beginning of the present century, and oddly enough in two different countries, and, so far as I know, without any intercommunication between the respective writers, two famous men clearly conceived the notion of uniting the whole of the sciences which deal with living matter into one whole, and of dealing with them as one discipline. In fact, I may say there were three men to whom this idea occurred contemporaneously, although there were but two who carried it into effect, and only one who worked it out completely. The persons to whom I refer were the eminent physiologist Bichat,[2] the great naturalist Lamarck, in France, and a distinguished

[1] Extracts from a lecture by Professor Huxley, delivered at the South Kensington Museum, on Saturday, December 16, 1876.

[2] See the distinction between the "sciences physiques" and the "sciences physiologiques" in the Anatomie Générale, 1801.

German, Treviranus. Bichat assumed the existence of a special group of "physiological" sciences. Lamarck, in a work published in 1801,[1] for the first time made use of the name "biologie," from the two Greek words which signify a *discourse upon life and living things*. About the same time it occurred to Treviranus that all those sciences which deal with living matter are essentially and fundamentally one, and ought to be treated as a whole, and in the year 1802 he published the first volume of what he also called Biologie. Treviranus's great merit consists in this, that he worked out his idea, and that he published the very remarkable book to which I refer, which consists of six volumes, and which occupied him for twenty years, — from 1802 to 1822.

That is the origin of the term "biology," and that is how it has come about that all clear thinkers and lovers of consistent nomenclature have substituted for the old confusing name of natural history, which has conveyed so many meanings, the term biology, to denote the whole of the sciences which deal with living things, whether they be animals or whether they be plants.

Having now defined the meaning of the word biology, and having indicated the general scope of biological science, I turn to my second question, which is, Why should we study biology? Possibly the time may come when that will seem a very odd question. That we, living creatures, should not feel a certain amount of interest in what it is that constitutes our life will eventually, under altered ideas of the fittest objects of human inquiry, seem to be a singular phenomenon; but at present, judging by the practice of teachers and educators, this would seem to be a matter that does not concern us at all. I propose to put before you a few considerations which I dare say many of you will be familiar with already, but which will suffice to show — not fully, because to demonstrate this point fully would take a great many lectures — that there are some very good and substantial reasons why it may be advisable that we should know something about this branch of human learning. I myself entirely agree with another sentiment of the philosopher of Malmesbury, that "the scope of all speculation is the performance of some action or thing to be done," and I have not any very great respect for or interest in mere knowing as such. I judge of the value of human pursuits by their bearing upon human interests, — in other

[1] Hydrogéologie, an. x., 1801.

words, by their utility; but I should like that we should quite clearly understand what it is that we mean by this word "utility." Now, in an Englishman's mouth, it generally means that by which we get pudding or praise, or both. I have no doubt that is one meaning of the word utility, but it by no means includes all I mean by utility. I think that knowledge of every kind is useful in proportion as it tends to give people right ideas, which are essential to the foundation of right practice, and to remove wrong ideas, which are the no less essential foundations and fertile mothers of every description of error in practice. And, upon the whole, inasmuch as this world is, after all, whatever practical people may say, absolutely governed by ideas, and very often by the wildest and most hypothetical ideas, it is a matter of the very greatest importance that our theories of things, and even of things that seem a long way apart from our daily lives, should be as far as possible true, and as far as possible removed from error. It is not only in the coarser practical sense of the word utility, but in this higher and broader sense, that I measure the value of the study of biology by its utility, and I shall try to point out to you that you will feel the need of some knowledge of biology at a great many turns of this present nineteenth-century life of ours. For example, most of us lay great and very just stress upon the conception which is entertained of the position of man in this universe, and his relation to the rest of nature. We have almost all of us been told, and most of us hold by the tradition, that man occupies an isolated and peculiar position in nature; that though he is in the world he is not of the world; that his relations to things about him are of a remote character, that his origin is recent, his duration likely to be short, and that he is the great central figure round which other things in this world revolve. But this is not what the biologists tell us. At the present moment you will be kind enough to separate me from them, because it is in no way essential to my argument just now that I should advocate their views. Don't suppose that I am saying this for the purpose of escaping the responsibility of their beliefs, because at other times and in other places I do not think that point has been left doubtful; but I want clearly to point out to you that for my present argument they may all be wrong; nevertheless, my argument will hold good. The biologists tell us that all this is an entire mistake. They turn to the physical organization of man. They examine his whole structure, his bony frame, and all that clothes it. They resolve him into the finest particles

into which the microscope will enable them to break him up. They consider the performance of his various functions and activities, and they look at the manner in which he occurs on the surface of the world. Then they turn to other animals, and, taking the first handy domestic animal, — say a dog, — they profess to be able to demonstrate that the analysis of the dog leads them in gross to precisely the same results as the analysis of the man; that they find almost identically the same bones, having the same relations; that they can name the muscles of the dog by the names of the muscles of the man, and the nerves of the dog by those of the nerves of the man, and that such structures and organs of sense as we find in the man, such also we find in the dog; they analyze the brain and spinal cord, and find the nomenclature which does for the one answer for the other. They carry their microscopic inquiries in the case of the dog as far as they can, and they find that his body is resolvable into the same elements as those of the man. Moreover, they trace back the dog's and the man's development, and they find that at a certain stage of their existence the two creatures are not distinguishable the one from the other; they find that the dog and his kind have a certain distribution over the surface of the world comparable in its way to the distribution of the human species. What is true of the dog they tell us is true of all the higher animals; and they find that for the whole of these creatures they can lay down a common plan, and regard the man and the dog, the horse and the ox, as minor modifications of one great fundamental unity. Moreover, the investigations of the last three quarters of a century have proved, they tell us, that similar inquiries carried out through all the different kinds of animals which are met with in nature will lead us, not in one straight series, but by many roads, step by step, gradation by gradation, from man at the summit to specks of animated jelly at the bottom of the series; so that the idea of Leibnitz and of Bonnet, that animals form a great scale of being in which there is a series of gradations from the most complicated form to the lowest and simplest, — that idea, though not exactly in the form in which it was propounded by those philosophers, turns out to be substantially correct. More than this, when biologists pursue their investigations into the vegetable world, they find that they can in the same way follow out the structure of the plant from the most gigantic and complicated trees through a similar series of gradations until they arrive at similar specks of animated jelly, which they are puzzled to distinguish from those which they reached by the animal road.

Thus they have arrived at the conclusion that a fundamental uniformity of structure pervades the animal and vegetable worlds, and that plants and animals differ from one another simply as modifications of the same great general plan.

Again, they tell us the same story in regard to the study of function. They admit the large and important interval which, at the present time, separates the manifestations of the mental faculties observable in the higher forms of mankind, and even in the lower forms, such as we know them, mentally from those exhibited by other animals; but, at the same time, they tell us that the foundations or rudiments of almost all the faculties of man are to be met with in the lower animals; that there is a unity of mental faculty as well as of bodily structure, and that here also the difference is a difference of degree and not of kind. I said "almost all" for a reason. Among the many distinctions which have been drawn between the lower creatures and ourselves, there is one which is hardly ever insisted on,[1] but which may be fitly spoken of in a place so largely devoted to art as that in which we are assembled. It is this, that while among various kinds of animals it is possible to discover traces of all the other faculties of man, especially the faculty of mimicry, yet that particular form of mimicry which shows itself in the imitation of form, either by modeling or by drawing, is not to be met with. As far as I know, there is no sculpture or modeling, and decidedly no painting or drawing of animal origin. I mention the fact in order that such comfort may be derived therefrom as artists may feel inclined to take.

If what the biologists tell us is true, it will be needful for us to get rid of our erroneous conceptions of man and of his place in nature, and substitute for them right ones.

Granted that biology is something worth studying, what is the best way of studying it? Here I must point out that, since biology is a physical science, the method of studying it must needs be analogous to that which is followed in the other physical sciences. It has now long been recognized that if a man wishes to be a chemist it is not only necessary that he should read chemical books and attend chemical lectures, but that he should actually himself perform the fundamental experiments in the laboratory, and know exactly what the words which he finds in his books and hears from his teachers mean. If he does not do that, he may read till the crack of doom, but he will never know

[1] I think that Professor Allman was the first to draw attention to it.

much about chemistry. That is what every chemist will tell you, and the physicist will do the same for his branch of science. The great changes and improvements in physical and chemical scientific education which have taken place of late have all resulted from the combination of practical teaching with the reading of books and with the hearing of lectures. The same thing is true in biology. Nobody will ever know anything about biology, except in a dilettant "paper-philosopher" way, who contents himself with reading books on botany, zoölogy, and the like; and the reason of this is simple and easy to understand. It is, that all language is merely symbolical of the things of which it treats; the more complicated the things, the more bare is the symbol, and the more its verbal definition requires to be supplemented by the information derived directly from the handling, and the seeing, and the touching of the thing symbolized: that is really what is at the bottom of the whole matter. It is plain common sense, as all truth in the long run is, only common sense clarified. If you want a man to be a tea-merchant, you don't tell him to read books about China or about tea, but you put him into a tea-merchant's office, where he has the handling, the smelling, and the tasting of tea. Without the sort of knowledge which can be gained only in this practical way, his exploits as a tea-merchant will soon come to a bankrupt termination. The paper-philosophers are under the delusion that physical science can be mastered as literary accomplishments are acquired, but unfortunately it is not so. You may read any quantity of books, and you may be almost as ignorant as you were at starting if you don't have, at the back of your minds, the change for words in definite images which can only be acquired through the operation of your observing faculties on the phenomena of nature.

It may be said: "That is all very well, but you told us just now that there are probably something like a quarter of a million different kinds of living and extinct animals and plants, and a human life could not suffice for the examination of one fiftieth part of all this." That is true, but then comes the great convenience of the way things are arranged; which is, that, although there are these immense numbers of different kinds of living things in existence, yet they are built up, after all, upon marvelously few plans.

There are, I suppose, about 100,000 species of insects, if not more, and yet anybody who knows one insect — if a properly

chosen one — will be able to have a very fair conception of the structure of the whole. I do not mean to say he will know that structure thoroughly, or as well as it is desirable he should know it, but he will have enough real knowledge to enable him to understand what he reads, to have genuine images in his mind of those structures which become so variously modified in all the forms of insects he has not seen. In fact, there are such things as types of form among animals and vegetables, and for the purpose of getting a definite knowledge of what constitutes the leading modifications of animal and plant life it is not needful to examine more than a comparatively small number of animals and plants.

Let me tell you what we do in the biological laboratory in the building adjacent to this. There I lecture to a class of students daily for about four and a half months, and my class have, of course, their text-books; but the essential part of the whole teaching, and that which I regard as really the most important part of it, is a laboratory for practical work, which is simply a room with all the materials arranged for ordinary dissection. We have tables properly arranged in regard to light, microscopes, and dissecting instruments, and we work through the structure of a certain number of animals and plants. As, for example, among the plants we take a yeast plant, a *Protococcus*, a common mould, a *Chara*, a fern, and some flowering plant; among the animals, we examine such things as an amœba, a *Vorticella*, and a fresh-water polyp. We dissect a star-fish, an earth-worm, a snail, a squid, and a fresh-water mussel. We examine a lobster and a craw-fish and a black beetle. We go on to a common skate, a cod-fish, a frog, a tortoise, a pigeon, and a rabbit, and that takes us about all the time we have to give. The purpose of this course is not to make skilled dissectors, but to give every student a clear and definite conception, by means of sense-images, of the characteristic structure of each of the leading modifications of the animal kingdom; and that is perfectly possible, by going no further than the length of that list of forms which I have enumerated. If a man knows the structure of the animals I have mentioned, he has a clear and exact, however limited, apprehension of the essential features of the organization of all those great divisions of the animal and vegetable kingdoms to which the forms I have mentioned severally belong. And it then becomes possible for him to read with profit, because, every time he meets with the name of a structure, he has a definite image in his mind of what the

name means in the particular creature he is reading about, and therefore the reading is not mere reading. It is not mere repetition of words; but every term employed in the description, we will say, of a horse or of an elephant, will call up the image of the things he had seen in the rabbit, and he is able to form a distinct conception of that which he has not seen as a modification of that which he has seen.

I find this system to yield excellent results, and I have no hesitation whatever in saying that any one who has gone through such a course attentively is in a better position to form a conception of the great truths of biology, especially of morphology (which is what we chiefly deal with), than if he had merely read all the books on that topic put together.

The connection of this discourse with the Loan Collection of Scientific Apparatus arises out of the exhibition in that collection of aids to our laboratory work. Such of you as have visited that very interesting collection may have noticed a series of diagrams and of preparations illustrating the structure of a frog. Those diagrams and preparations have been made for the use of the students in the biological laboratory. Similar diagrams and preparations, illustrating the structure of all the other forms of life we examine, are either made or in course of preparation. Thus the student has before him, first, a picture of the structure he ought to see; secondly, the structure itself worked out; and if, with these aids, and such needful explanations and practical hints as a demonstrator can supply, he cannot make out the facts for himself in the materials supplied to him, he had better take to some other pursuit than that of biological science.

I should have been glad to have said a few words about the use of museums in the study of biology, but I see that my time is becoming short, and I have yet another question to answer. Nevertheless, I must, at the risk of wearying you, say a word or two upon that important subject of museums. Without doubt, there are no helps to the study of biology, or rather to some branches of it, which are or may be more important than natural-history museums; but, in order to take this place in regard to biology, they must be museums of the future. The museums of the present do not do by any means so much for us as they might do. I do not wish to particularize, but I dare say many of you seeking knowledge, or in the laudable desire to employ a holiday usefully, have visited some great natural-history museum. You have walked through a quarter of a mile of animals well

stuffed, with their long names written out underneath them; and, unless your experience is very different from that of most people, the upshot of it all is that you leave that splendid pile with sore feet, a bad headache, and a general idea that the animal kingdom is a mighty maze without a plan. I do not think that a museum which brings about this result has done all that may reasonably be expected of such an institution. What is needed in a collection of natural history is, that it should be made as accessible and as useful as possible on the one hand to the general public, and on the other to scientific workers. That need is not met by constructing a sort of happy hunting ground of miles of glass cases, and, under the pretense of exhibiting everything, putting the maximum amount of obstacles in the way of those who wish properly to see anything.

What the public want is easy and unhindered access to such a collection as they can understand and appreciate; and what the men of science want is similar access to the materials of science. To this end the vast mass of objects of natural history should be divided into two parts, — one open to the public, the other to men of science, every day, and all day long. The former division should exemplify all the more important and interesting forms of life. Explanatory tablets should be attached to them, and catalogues, containing clearly written expositions of the general significance of the objects exhibited, should be provided. The latter division should contain, packed into a comparatively small space, the objects of purely scientific interest. For example, we will say I am an ornithologist. I go to see a collection of birds. It is a positive nuisance to have them stuffed. It is not only sheer waste, but I have to reckon with the ideas of the bird stuffer, while if I have the skin and nobody has interfered with it, I can form my own judgment as to what the bird was like. For ornithological purposes, what is needed is not glass cases full of stuffed birds on perches, but convenient drawers, into each of which a great quantity of skins will go. They occupy no great space, and do not require any expenditure beyond their original cost. But, for the purpose of the public, who want to learn, indeed, but do not seek for minute and technical knowledge, the case is different. What one of the general public, walking into a collection of birds, desires to see, is not all the birds that can be got together; he does not want to compare a hundred species of the sparrow tribe side by side; but he wishes to know what a bird is, and what are the great modifications of bird structure,

and to be able to get at that knowledge easily. What will best serve his purpose is a comparatively small number of birds, carefully selected, and artistically as well as accurately set up, with their different ages, their nests, their young, their eggs, and their skeletons side by side, and, in accordance with the admirable plan which is pursued in this museum, a tablet, telling the spectator, in legible characters, what they are and what they mean. For the instruction and recreation of the public, such a typical collection would be of far greater value than any many-acred imitation of Noah's ark.

Lastly comes the question as to when biological study may best be pursued. I do not see any valid reason why it should not be made, to a certain extent, a part of ordinary school training. I have long advocated this view, and I am perfectly certain that it can be carried out with ease, and not only with ease, but with very considerable profit to those who are taught; but then such instruction must be adapted to the minds and needs of the scholars. They used to have a very odd way of teaching the classical languages when I was a boy. The first task set you was to learn the rules of the Latin grammar in the Latin language, — that being the language you were going to learn. I thought then that this was an odd way of learning a language, but did not venture to rebel against the judgment of my superiors. Now, perhaps, I am not so modest as I was then, and I allow myself to think it was a very absurd fashion. But it would be no less absurd if we were to set about teaching biology by putting into the hands of boys a series of definitions of the classes and orders of the animal kingdom, and making them repeat them by heart. That is a very favorite method of teaching, so that I sometimes fancy the spirit of the old classical system has entered into the new scientific system, in which case I would much rather that any pretense at scientific teaching were abolished altogether. What really has to be done is to get into the young mind some notion of what animal and vegetable life is. You have to consider in this matter practical convenience as well as other things. There are difficulties in the way of a lot of boys making messes with slugs and snails; it might not work in practice. But there is a very convenient and handy animal which everybody has at hand, and that is himself; and it is a very easy and simple matter to obtain common plants. Hence, the broader facts of anatomy and physiology can be taught to young people in a very real fashion by dealing with

the broad facts of human structure, such as hearts, lungs, and livers. Such viscera as they cannot very well examine in themselves may be obtained from the nearest butcher's shop. In respect to teaching them something about the biology of plants, there is no practical difficulty, because almost any of the common plants will do, and plants do not make a mess, — at least they do not make an unpleasant mess; so that, in my judgment, the best form of biology for teaching to very young people is elementary human physiology on the one hand, and the elements of botany on the other; beyond that I do not think it will be feasible to advance for some time to come. But then I see no reason why in secondary schools, and in the science classes, which are under the control of the science and art department — and which, I may say, in passing, have, in my judgment, done so very much for the diffusion of a knowledge over the country — I think that, in those cases, we may go further, and we may hope to see instruction in the elements of biology carried out, not, perhaps, to the same extent, but still upon somewhat the same principle, as we do here. There is no difficulty, when you have to deal with students of the ages of fifteen or sixteen, in practicing a little dissection and getting a notion, at any rate, of the four or five great modifications of the animal form, and the like is true in regard to plants.

While, lastly, to all those who are studying biological science with a view to their own edification, or with the intention of becoming zoölogists or botanists; to all those who intend to pursue physiology — and especially to those who propose to employ the working years of their lives in the practice of medicine — I say that there is no training so fitted, or which may be of such important service to them, as the thorough discipline in practical biological work which I have sketched out as being pursued in the laboratory hard by.

I may add that, beyond all these different classes of persons who may profit by the study of biology, there is yet one other. I remember, a number of years ago, that a gentleman who was a vehement opponent of Mr. Darwin's views, and had written some terrible articles against them, applied to me to know what was the best way in which he could acquaint himself with the strongest arguments in favor of evolution. I wrote back in all good faith and simplicity, recommending him to go through a course of comparative anatomy and physiology, and then to study development. I am sorry to say he was very much displeased, as

people often are with good advice. Notwithstanding this discouraging result, I venture, as a parting word, to repeat the suggestion, and to say to all the more or less acute lay and clerical paper-philosophers [1] who venture into the regions of biological controversy: Get a little sound, thorough, practical, elementary instruction in biology.

ON THE PEOPLING OF AMERICA.

BY AUG. R. GROTE.[2]

THE conclusion was first reached by myself in a paper [3] read before the American Association, August, 1875 (since reprinted in several journals), that we should find colonies of Arctic man upon mountains in the temperate zone of North America, had all the conditions for his survival on these elevations been fulfilled in his case as they have been in that of certain plants and animals. That the Eskimos are the existing representatives of the man of the American Glacial epoch, just as the White Mountain butterfly (*Oeneis semidea*) is the living representative of a colony of the genus planted on the retiring of the ice from the valley of the White Mountains, seemed to me at that time a natural conclusion. In a subsequent paper,[4] Dr. C. C. Abbott, basing his remarks on paleolithic implements discovered by himself in New Jersey, says: "It is fair to presume that the first human beings that dwelt along the shores of the Delaware were really the same people as the present inhabitants of Arctic America." The title of Dr. Abbott's paper is Traces of an American Autochthon, and in it he institutes a comparison of the paleolithic implements of New Jersey with those of Southern France. According to a foot-note of Dr. Abbott's it appears that in 1875 Dr. Rink [5] was "strongly of opinion that the Eskimo are an

[1] Writers of this stamp are fond of talking about the Baconian method. I beg them, therefore, to lay to heart these two weighty sayings of the herald of Modern Science: —

"Syllogismus ex propositionibus constat, propositiones ex verbis, verba notionum tesseræ sunt. Itaque si notiones ipsæ (*id quod basis rei est*) confusæ sint et temere a rebus abstractæ, nihil in iis quæ superstruuntur est firmitudinis." — Novum Organon ii. 14.

"Huic autem vanitati nonnulli ex modernis summa levitate ita indulserunt, ut in primo capitulo Geneseos et in libro Job et aliis scripturis sacris, philosophiam naturalem fundare conati sint; *inter vivos quærentes mortua.*" — Ibid. 65.

[2] Read before the Buffalo Society of Natural Sciences, February 2, 1877.

[3] Effect of the Glacial Epoch upon the Distribution of Insects in North America, Proc. Am. Assoc. Adv. Sci., Detroit Meeting, B. Natural History, 225.

[4] Am. Nat., June, 1876, 329.

[5] Tales and Traditions of the Eskimo, London, 1875.

indigenous American people who have been pushed northwards by the intrusive Indian tribes." A note of mine in objection to the idea that paleolithic man in North America is an "autochthon" will be found in The American Naturalist for July, 1876, p. 432.

It will be seen that, independently of each other and from different stand-points, the fact that we have in the Eskimo a survival of paleolithic man in North America has been arrived at by Dr. Abbott and, previously, by myself. The subsequent discovery by Professor Dana[1] of remains of the reindeer in glacial deposits in the valley of the Connecticut, and the determination of the beds in which the rough stone implements were found as ancient moraines, help to assign a geological age to the presence of man in North America, as well as to give a picture of his surroundings. I have endeavored to carry out the original idea which I entertained, that glacial man would be found to have suffered an equal fate with the fauna of the Ice period, by a study of migrations.

In a lecture delivered in the course of the Buffalo Society of Natural Sciences[2] January 6, 1877, I published the conclusions arrived at, already briefly sketched in my note in The American Naturalist for July of the preceding year. I proposed to distinguish: "A *primitive* migration, one influenced solely by physical causes affecting man's existence, and which must have been in more extensive operation in early times when he was unprovided with means of his own invention against unfriendly changes in his surroundings. Such migrations, or a modified survival of them, are operative now among our Indians, who move from place to place with the game upon which they subsist and with the season. A *culture* migration, one arising out of a certain stage of intellectual advancement when the movements of man are determined by ultimate and not immediate considerations. The movements of the Indo-European races fall within this category. Besides these is to be distinguished an *accidental* migration, which man has submitted to against his will. The accidental migrations of man may be considered as belonging to the epochs of culture migration, since they must more usually have occurred with races advanced in the art of navigation. A separation of individuals from communities under the pressure of storms, earthquakes, volcanic eruptions, etc., may have happened, however, in the earliest times."

[1] Am. Jour. Sci. Arts, 353, November, 1875.

[2] Buffalo Courier, January 7, 1877.

It will be seen that I differ from Dr. Abbott by considering the presence of the progenitors of the Eskimo over the main belt of this continent during the Ice period as due to "a primitive and unconscious migration determined by the shifting of their congenial surroundings." It does not appear that Dr. Rink couples the migration of the Eskimo with the movement of the ice over this continent. Indeed, his idea seems opposed to this, and does not imply any relation between the Eskimo and the Ice period.

These discoveries and considerations open up the question of Tertiary man. It is certain, as I have elsewhere suggested, that man could not have originated at the foot of the glacier. The ice must have met him, towards the close of the Tertiary, in the northern parts of Asia and America and forced him southward; or, at a later time, it must have found him on the main belt of this continent. The Tertiary origin of man is presupposed from the fact that he had submitted to a race modification fitting him to endure the cold. Some support for these ideas may be found in examining northern strata; it must be borne in mind, however, that the north has never been free from ice since the close of the Pliocene to this day.

It would appear more sensible, in view of the present ascertained facts of science, that for the original Tertiary form of man we should search a territory inhabited at that time by animals the nearest related to him. Considerations of this kind will prevent us from entertaining the belief that man originated in America. We must still believe that America has always been for man the New World.

If we turn to the detached Antarctic lands, covered by glaciers descending to form an ice wall along their coasts, to be fretted away by the beating of the ocean waves, we see that other sciences may be advanced by their exploration, but anthropology only indirectly. In February, 1842, Ross reached the most southern point yet attained, lat. 78° 11′, long. 161° 27′W., and it is strange that both he and Weddell [1] report an open sea before them to the south, as Kane did to the north.

So soon as Arctic America is explored by means of the establishment of permanent stations of observation, akin to that in operation on Mount Washington, a system recently recommended in this country as well as in Europe, important data as to the introduction of man on this continent cannot fail to be brought to light. The establishment of an international scien-

[1] Neumayer, Zeits. Ges. Erdk., 1872.

tific service for the observation of astronomical, meteorological, geological, and zoölogical phenomena commends itself at the present time to the more civilized powers. The different governments established by the white races should contribute their quota of the expenses for the establishment and maintenance of posts of observation in different localities over the globe, to be decided upon by commissions of specialists. In time of war such posts should be held neutral, as well as their service, under a flag and protected by the operation of international law. In the case of the Arctic regions, Great Britain, the United States, Russia, and Scandinavia are the more interested from their geographical position; yet other powers are directly interested in the solution of the different problems which will be offered though the knowledge of those parts of the earth's surface. In Madagascar we must also expect some evidence to be forthcoming with reference to the origin of man. A definite settlement of the latter question can be arrived at if evolution be true. Is not this a question to call for the active interest of the cultivated races? Its settlement would greatly advance our material interests as a species by giving us a mental habit in accordance with the facts in the case. I think that the prospect alone of arriving at a solution of this question should prompt concerted action, either by a scientific service or such other means as experience may prefer.

When we examine into the question of the stone implements, which prove the fact of the presence of man, we must see that the earlier man must have first used a stone as he found it. "There must have been a time when men picked up such stones as came in their way at the moment with which to throw at animals, to break their food, to injure their fellow men. Such stones, unaltered by use, can no longer be identified." There will be an imperfection here in the record from implements.

The difficulty of supposing man to have been first introduced into America during the Quarternary period lies in the fact that he must have been in the Stone age when the migration was made. This difficulty vanishes if, as I suppose, man entered upon possession of this continent during the Pliocene and before the Ice period had interfered with a warm climate in the north. This will leave us free to consider American civilizations indigenous. The idea is here suggested that the Ice period acted as a barrier to inter-communication between Asia and North America. The part allowed hitherto by anthropologists to accidental migration

in the peopling of North America will be found, I think, exaggerated. We may conceive that this peopling was effected during the Tertiary; that the ice modified races of Pliocene man, existing in the north of Asia and America, forced them southward, and then drew them back to the locality where they had undergone their original modification. Also, we may suggest that other than Arctic man may have existed across the main belt of this continent during the Pliocene, and that his subsequent intellectual development, as we find it recorded in the West, Mexico, and South America, etc., is the result of his environment acting upon his isolated condition.

The object of the present paper is to call attention to this hypothesis, which must be studied from the point of view that man's earlier migrations were not distinguishable in kind from those of lower animals. It seems to me quite evident that, at a time when instinct was developing into reason, the migrations of man must have had a motive which was not far removed from that influencing certain lower animals under the same circumstances. If we concede this, it follows that the objects of man's primitive migrations were more immediate, and of his culture migrations more remote. This one fact, that the distribution of man over the surface of the globe is more general than that of any other animal, will support the view that, through the fertility of his resources, he has been able to outgrow the limitations originally imposed upon him. But these resources must have been brought into play by experience; and their cost was surely the premature perishment of many of the kind.[1] During the process, then, which resulted in the race modification of the Eskimos, their original numbers must have been decreased by the slowly but ever increasing cold of the northern regions, until experience and physical adaptation combined brought them to a state of comparative stability as a race.

We must also consider that the farther back we go the nearer we must come to a common race of man, supposing the theory of the essential unity of his origin to be true, while I think the probable effect of the Ice period upon climate and the present development of man has not been hitherto sufficiently considered. The entire environment must be taken into consideration,

[1] Many birds witness the death of their companions by the hunter with indifference when first discovered by man, but afterwards, from observation, avail themselves of all their natural means to escape from the danger. It is possible that it was not difficult for Tertiary man to supply himself with animal food even with his imperfect weapons.

however complex it is and at whatsoever cost to us the knowledge of it is to be attained, before we can grasp the true picture of the succession of events which have resulted in man as we now find him on the different lands of the globe. With the thinking minds of our race, the question of the origin of man is the question of the century.

The hypotheses as to the manner in which the early peoplings of America were effected, developed in the present and previous papers of mine, are as follows: —

(1.) That during the Tertiary period man had spread from Equatorial lands on the eastern hemisphere to Northern Asia, and had then crossed into America from the North.

(2.) That in at least as early as Pliocene time man had migrated down the high lands adjacent to the mountainous backbone running along the western side of the two Americas.

(3.) That the Ice-period produced a race modification of the man living in the extreme north, and that the advance of the ice prevented further communication between the Old and the New Worlds until comparatively recent times.

(4.) That this race accompanied the great glacier on its advance and retirement over North American territory, and that the existing representatives of this race are the Eskimos.

THE POLAR COLONIZATION PLAN.

BY CAPT. H. W. HOWGATE, U. S. N.

THE expeditions of Captain Hall in the Polaris, in 1871, and of Captain Nares in the Alert and Discovery, in 1875, have shown that by the use of steam it is a comparatively easy matter to reach the entrance to Robeson's Channel in latitude 81° north, and that the serious difficulties to be overcome in reaching the Pole lie beyond that point. Parties from the two expeditions have made fair surveys one hundred and forty miles north of this, leaving only about four hundred miles of unexplored region between that and the goal of modern geographers, — the Pole.

When Captain Hall reached the upper extremity of Robeson's Channel the lookout of the Polaris reported open water in sight and just beyond the pack which surrounded the vessel and prevented further progress. This open water was afterwards seen from the cape at the northern opening of Newman's Bay, and it

was the opinion of the crew of that ill-fated vessel that if she had been but the fraction of an hour earlier in reaching the channel they could have steamed unobstructed over a veritable "open sea" to the Pole itself. We know that they did not succeed, but were forced to winter almost within sight of this sea, and subsequently, disheartened by the loss of their gallant commander, abandoned the enterprise.

Where this open water was found, Captain Nares in 1875 and 1876 found solid, impenetrable ice, through which no vessel could force its way, and over which it was equally impossible for sledge parties to work.

These facts appear to show that within the Arctic circle the seasons vary as markedly as in more temperate southern latitudes, and that the icy barriers to the Pole are sometimes broken up by favoring winds and temperature. To reach the Pole prompt advantage must be taken of such favoring circumstances, and to do this with the greatest certainty and with the least expenditure of time, money, and human life, it is essential that the exploring party be on the ground at the very time the ice breaks up and opens the gate-way to the long-sought prize. This can be done only by colonizing a few hardy, resolute, and experienced men at some point near the borders of the Polar Sea, and the most favorable one for the purpose appears to be that where the Discovery wintered last year.

Such a party should consist of at least fifty men, and should be provided with provisions and other necessary supplies for three years, at the end of which period they should be visited, and if still unsuccessful in accomplishing the object, revictualled and again left to their work. Captain Hall spent eight years among the Esquimaux, and each year found himself better fitted to withstand the severity of the Arctic circle, and the party of which I speak would in like manner become acclimated, and eventually succeed in accomplishing the long-desired end. With a strong, substantial building, such as could easily be carried on shipboard, the party could be made as comfortable and as safe from atmospheric dangers as are the men of the signal service stationed on the summits of Pike's Peak and Mount Washington, or the employés of the Hudson's Bay Company stationed at Fort York, where a temperature of —60° is not uncommon. A good supply of medicine, a skillful surgeon, and such fresh provision as could be found by hunting parties would enable them to keep off scurvy and to maintain as good a sanitary condition as the

inhabitants of Godhaven, in Greenland. Game was found in fair quantities by the Polaris party on the Greenland coast, and by those from the Alert and Discovery on the mainland to the west, especially in the vicinity of the last-named vessel, where fifty-four musk-oxen were killed during the season, with quantities of other and smaller game. A seam of good coal was also found by the Discovery's party, which would render the question of fuel a light one, and thus remove one of the greatest difficulties hitherto found by Arctic voyagers.

The principal depot or post should be located upon Lady Franklin Bay, between latitude 81° and 82°, and there is no question that this can be reached with a steam vessel, as Captain Hall went as high as Cape Union, between latitude 82° and 83°, with the Polaris, and Captain Nares still higher with the Alert. It is probable that the last-named point may be reached with the vessel, in which case coal and provisions could be deposited there to form a secondary base of operations for the exploring party. If this latter can be done, the road to the Pole will be shortened by about ninety miles in distance and three weeks or more in time, two very important items. It should be clearly understood that the only use to be made of the vessel, which it is hoped will be obtained from the Navy Department, is in the transportation of the men and supplies to the location of the colony. When this is done the vessel will return to the United States and await further instructions. An annual visit might be made to the colony, to carry fresh food and supplies, to keep its members informed of events occurring in the outside world, and bear them news and letters from anxious relatives; to bring back news of progress made and of a private character to friends; also, if necessary, to bring back invalided members of the expedition, and carry out fresh colonists to take their places. The permanent colony should consist of fifty chosen men, mustered into the service of the United States, three commissioned officers, and two surgeons; all to be selected with a view to their especial fitness for work, the young, able-bodied, resolute men, who can be depended upon to carry out instructions to the extreme limit of human endurance. An astronomer and two or more naturalists, to be selected by the National Academy of Sciences, and to work under instructions from that body, but subject to such general supervision and direction from the head of the expedition as is customary at all posts in charge of an officer of the United States, should accompany the expedition. One or more mem-

bers of the regular force should be competent to make meteorological observations, and to communicate by telegraph and signals whenever such communication becomes necessary.

To the expeditionary corps brought from the United States should be added a number of Esquimaux to serve as hunters, guides, etc., and who can be taken over with their families from Disco or Upernavik, in Greenland, and also an ample number of the Esquimaux dogs, so indispensable for sledging and so useful as food when their capacity for work is gone.

The outfit of the expedition should include some two hundred miles or more of copper wire, to connect the colony at Lady Franklin Bay with the subsidiary depot at Cape Union, and thence northward as far as practicable. Copper wire is strong, light, flexible, and a good conductor, and can be worked while lying upon the dry snow or ice without support. The necessary battery, material, and instruments should be taken to equip the amount of line, and the battery could be kept permanently at the Bay station, where, fuel being abundant, it could be kept from freezing. A few sets of signal equipments, such as are used in the army signal service, would also form an indispensable part of the outfit, and all of the men should be instructed in their use and in the signal code. Thus provided with means of communication the sledging parties could move forward with confidence, as they would be able, when necessary, to call upon their comrades who remained behind for advice or assistance. Instead of discouraging further effort, the failure of Nares's expedition from the causes named should stimulate fresh endeavors, and hold out a fair prospect of success. At any rate, the little colony on Lady Franklin Bay, during their three years' residence, besides having the opportunity of selecting an open season and becoming thoroughly hardened and acclimated, would have their work narrowed down to a common focus, — the pathway due north. The work of the Nares expedition clears the way for a direct movement upon the Pole. The explorations westward along the coast by Lieutnant Aldrich, and eastward by Lieutenant Beaumont, obviate the necessity for similar work now. Upon landing and unloading, the stores and provisions quarters should be erected, and the vessel, returning to the United States, would leave behind her a thoroughly equipped, self-supporting, and self-reliant colony which would push, ever northward, the limits of discovery.

The attempt to draw the loaded sledges by means of mere manual labor should not be made unless it should become in any

particular instance a matter of absolute necessity, as it is sure to result disastrously, and seems to have been one of the causes of failure of the Nares expedition. The expedition from the colony to the Pole may consist of eight sledges, with six men to each sledge, the distance to be traveled being some four hundred miles, divided into eight stages of fifty miles each. At the end of the first stage one sledge could be sent back. A portion of the provisions which it originally carried would have been consumed, and the rest would have been deposited in a *cache* in the ice secure from Arctic animals. At the end of the second stage the second sledge would be sent back; at the close of the third stage the third sledge would take up its homeward journey, and following out this plan only a single sledge would remain. The returning sledges being but lightly freighted, and traveling, moreover, a route already pioneered, several of their hands could be retained so as to man the eighth sledge with ten or more explorers. This last sledge with its full complement would perform the most important work of all. It would press forward, reach the Pole, make the necessary observations, and then return. Upon its homeward journey it would follow the route already made in the forward journey, and would find provisions at each successive cache.

During the summer there are probably long lanes of water free of ice from the upper end of Smith's Sound, and following these, against the downward-flowing current, a pathway will surely be found, practicable for boats, during some favoring season. Such favoring season and such a practicable pathway can be found only by men colonized as proposed at a point where — half the journey already safely completed — they will be ready, healthy, vigorous, acclimated, and unwearied by a long and perilous voyage; they will be ready and eager to seize the proffered opportunity. Failing such an opportunity, a chance barely possible, the alternating of sledge journeys still remains, and sledge journeys undertaken under better and more favorable auspices than any which have been as yet attempted.

The severity of the climate on Lady Franklin Bay and in the neighboring regions has been much exaggerated. To parties under cover it is not more trying than that at the summits of Mount Washington, in New Hampshire, or of Pike's Peak, in Colorado, as stated by a former member of one of Dr. Hayes's expeditions, who has since served a year upon the summit of the last-named mountain. The report on the Polaris expedition

shows that during the summer all the lowlands and elevations at Thank God Harbor (opposite Discovery Harbor on Lady Franklin Bay) were bare of snow and ice, excepting patches here and there in the shade of the rocks. The soil at that period was covered with a vegetation of moss interspersed with small plants and willows. The country abounds with life: seals, game, ducks, musk oxen, rabbits, wolves, foxes, bears, partridges, etc. Two seals were shot in the open water.

Again, there are several towns in Northern Asia inside the Arctic circle, and a flourishing city of Russia (Archangel) is not far from it. At Yakutsk, on the river Lena, the ground is frozen solid all the year round, and only thaws a few inches in depth during the hottest summer. Yet this is a town possessing a population of four thousand hardy, prosperous, and contented human beings.

Nostalgia, that dreaded foe of isolated men, found in the members of former exploring parties an easy prey through the long, sunless, Arctic night, and drove some to mutiny and others to suicide, while when the hour of deadly peril came — the supreme moment of despair — the stoutest heart was appalled by the knowledge that succor, if sent at all, must be guided by the merest chance, and that the rude cairn which covered his last resting-place or his frozen effigy upon some drifting ice floe might never meet the gaze of human eye. The new enterprise will go forth under far different auspices to seek a definite rendezvous from which every forward step will be duly chronicled, and the members of the expedition, well knowing that communication will be kept up for their aid, comfort, and supply, will strive with a keener endeavor for the long-coveted prize. Speaking of his expedition in 1861, Dr. Hayes says that the crew were always, and had been, in perfect health; that he was his own ship's doctor, and a doctor without a patient, and that, "believing in Democritus rather than Heraclitus, they had laughed the scurvy and all other sources of ill health to shame." Nor is the danger of Arctic exploration so great as it at first thought appears to be. A distinguished naval officer who has served in those regions states that "of all the seas visited by men-of-war the Arctic have proved the most healthy;" and Mr. Posthumus states, further, that since 1841 England and America have sent out thirty-two expeditions, the total number of deaths from which has been only thirty-eight men, or 1.7 per cent., a percentage which would appear much more favorable if the expeditions of the Germans, Swedes, and Norwegians were included.

To sum up, then, in brief: It is proposed to ascend a well-known and practicable channel to an equally well-known point where exploring parties have previously wintered, and there form a colony. From the post so formed no time will be spent in needless quests along the shore either east or west, as surveys there have already been completed; but starting afresh, the point of our beginning being the closing point of former expeditions, with all the information of our forerunners to commence with, better provisioned, equipped, and disciplined, with better means of intercommunication, thoroughly acclimated, and without the refuge of the ship to paralyze energy and sow the seeds of discontent and slothfulness. In other words: to use alike the partial successes and the partial failures of others, added to the utmost foresight, experience, and scientific aids to form the fulcrum of the Archimedean lever which shall move the Arctic world.

RECENT LITERATURE.

WALLACE'S GEOGRAPHICAL DISTRIBUTION OF ANIMALS.[1] — Although a complete work on this subject by a single writer — and the one under consideration applies, as the author intended it should, almost exclusively to land animals of a comparatively few orders — would in the present state of our knowledge be an impossibility, we know of no one, next to Mr. Darwin, who is better fitted for the task, by training both in the field and in the study, than Mr. Wallace. The work is comprehensive in scope and apparently accurate in details, while the subject is presented in the attractive, clear style of the distinguished author of the Malay Archipelago and the Contributions to the Theory of Natural Selection. It is written, as it should mainly be, in the light of the recent uniformitarian views in geology and the theory of evolution, though with occasional disregard of zoögeographical laws laid down by Humboldt, Brown, Schouw, Schmarda, Decandolle. Agassiz, Dana, and others whose names are not even mentioned in the work before us, no historical sketch of the subject being presented, an omission of considerable importance.

The work is divided into four parts: I. The Principles and General Phenomena of Distribution. II. On the Distribution of Extinct Animals. III. Zoölogical Geography; a Review of the Chief Forms of Life in the Several Regions and Sub-Regions, with the Indications they afford

[1] *The Geographical Distribution of Animals. With a Study of the Relations of Living and Extinct Faunas as elucidating the Past Changes of the Earth's Surface.* By ALFRED RUSSEL WALLACE. In two vols. With Maps and Illustrations. New York: Harper & Brothers. 1876. 8vo, pp. 503, 607. $10.00.

of Geographical Mutations. IV. Geographical Zoölogy; a Systematic Sketch of the Chief Families of Land Animals in their Geographical Relations.

The grand merit of the work, and one which will give a substantial foundation to the author's fame as a biologist, aside from his authorship, simultaneous with Darwin, of the doctrine of natural selection, is the endeavor to account, from a more extended range of study than any previous author, for the present diversity of life on the different continents, by a study of the fossil forms and of past geological changes. He discards the older notions of certain authors, as Humboldt, Schouw, and others, that the distribution of life over the globe is due primarily to differences in temperature and to physical barriers. In how broad a way our author has treated this subject may be seen by the chapter entitled Summary of the Past Changes and General Relations of the Several Regions, reprinted in the last number of this journal. As long ago as 1847 Agassiz stated in his Introduction to the Study of Natural History that "modification of types [on different continents was] not caused by climate," though he proposed no scientific explanation as to how they did originate. Mr. Wallace supposes that all land animals originated in the northern portion of the Europe-Asiatic continent, and thence migrated south into India, Australasia, Africa, and to North America by means of a supposed former polar continent of which Arctic America, Greenland, Iceland, Spitzbergen, and Nova Zembla are the remnants. South America, he suggests, was peopled from North America. This view we suppose to be original with the author, and the hypothesis seems to be supported by known palæontological facts, and may serve as a working theory until a better one is offered. Mr. Wallace's view that the primitive centre of distribution was in the Old World is based on the fact that life is more abundant and the continental mass larger than that of North America. Mr. Wallace quite thoroughly disposes of the notion, advanced by Heer, Murray, and others, of continental bridges, and fully recognizes the facts strenuously maintained for years by Dana and others, and proven by the late deep sea explorations, that the present ocean beds have always been such,[1] oscillations of the original continental masses and the evident former existence of an arctic Americo-European continent being sufficient to account for the regular and normal interchange of life, which palæontology shows must actually have occurred.

The limits of the six primary regions into which the earth's surface is divided by our author have been marked out by geological agencies

[1] "The preliminary studies above enumerated will, it is believed, enable us to see the bearing of many facts in the distribution of animals, that would otherwise be insoluble problems, and, what is hardly less valuable, will teach us to estimate the comparative importance of the various groups of animals, and to avoid the common error of cutting the gordian knot of each difficulty by vast hypothetical changes in existing continents and oceans, probably the most permanent features of our globe." (Vol. i., p. 9.)

almost wholly. When, however, we come to the zoölogical subregions, temperature and mountain barriers, rivers and deserts are factors for the most part, though not always duly recognized in this work, for climatic causes are, we think, not given sufficient prominence, and the correspondence between zones of temperatures, and the distribution of faunæ are too lightly discussed. For example, he rejects the idea of an arctic region with a circumpolar fauna, contrary to the well-founded views of Agassiz, Dana, Huxley, and others, though he gives some good reason for his own opinion. Mr. Wallace's six regions are those originally proposed by Sclater, namely, the Palæarctic, Ethiopian, Indian, Australian, Neotropical, and Nearctic.

Mr. Wallace disbelieves in the existence of an antarctic region, and we should be inclined to agree with him, but we see no good reason, if we are to confine ourselves to existing facts of distribution, for ignoring a seventh arctic region embracing all of America, Europe, and Asia north of the isothermal of 32°. We should follow Agassiz (1847) and others, as well as Huxley (1868) and put the northern limits of the Palæarctic and Nearctic regions, or Europe, Asia, and North America, respectively, south of the isothermal of 32°. In this case, we think, Mr. Wallace treats too lightly the importance of temperature in limiting zoögeographical regions, and is disposed to rely too strongly on the fact that this arctic region had in former times a warm climate, and supported a flora and fauna like that of north temperate Europe, Asia, and America. But the Glacial epoch destroyed the continuity of climate, and at the present time temperature is the prime factor in limiting life as regards this region of the globe. When we turn to the distribution of marine invertebrate life, a subject almost wholly ignored by Mr. Wallace, the extension into the arctic zone of Mr. Sclater's Nearctic and Palæarctic regions is entirely arbitrary. All the facts brought out by deep-sea researches and Scandinavian, British, and American marine zoölogists tend to prove most forcibly that there is a circumpolar fauna, no more European-Asiatic than American,[1] and that this fauna may, at great depths, where the temperature of the water is the same (as it actually is), extend to Cuba and underlie the tropical zone of life. In fact, the fauna of the sea is primarily polar or frigid, and tropical, and we believe that Messrs. Sclater and Wallace are quite wrong in ignoring the fact that even land animals share largely in this distribution. Indeed, in discussing the distribution of marine life, temperature is the main element in the limitation of zoölogical regions and subregions, as first shown by Professor J. D. Dana in 1853, in his essay on the geographical distribution of Crustacea, and again and again proved by marine zoölogists and the results of the explorations by the United States Coast Survey, by Scan-

[1] Since the publication of Mr. Wallace's work, in the Reports of the Valorous Expedition to Greenland, Mr. Jeffreys argues against and Mr. Norman in favor of the Greenland marine fauna being American rather than European.

(Fig. 28.) A SCENE IN CUBA, WITH CHARACTERISTIC ANIMALS.

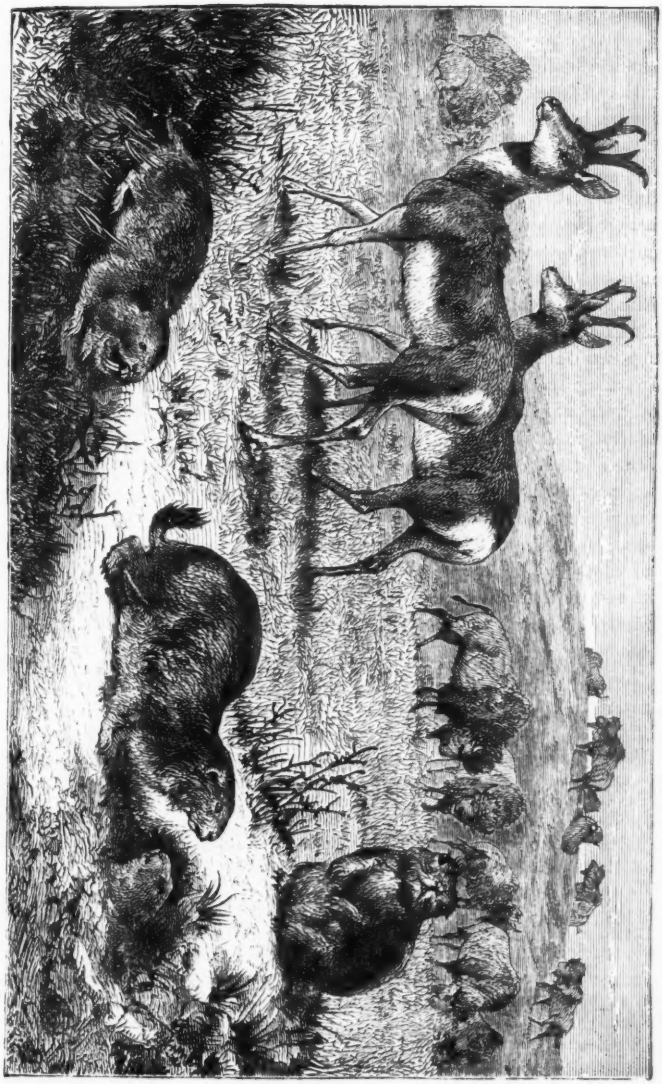
dinavian, and the Porcupine and Challenger, and other English expeditions. We are disposed to find some fault with the present work in not considering the subject from a stand-point so important as this.

To return to the theory as to the origin of the present distribution of life on the great continents by means of a migration from lands to the north. While the idea is evidently original with Mr. Wallace, he seems to have overlooked some suggestions made by writers in the United States previous to the publication of his work. More than twenty years ago Professor Asa Gray [1] proposed the hypothesis that the present vegetation of North America "or its proximate ancestry must have occupied the arctic and subarctic regions in Pliocene times, and that it had been gradually pushed southward as the temperature lowered and the glaciation advanced even beyond its present habitation." He also attempted to show that certain forms might survive in Japan and the Atlantic United States, "but not in intermediate regions of different distribution of heat and moisture." . . . . And it was thought that the occurrence of peculiarly North American genera in Europe in the Tertiary period (such as *Taxodium*, *Carya*, *Liquidamber*, *Sassafras*, *Negundo*, etc.) might be best explained on the assumption of early interchange and diffusion through North Asia rather than by that of the fabled Atlantis." These views were confirmed by Lesquereux. In 1873 the reviewer applied this hypothesis to the origin of the distribution of animals, particularly insects.[2] We then, in discussing the origin of our North American fauna, drew the inference that "cospecific or congeneric forms occurring in California and Europe and Asia are the remnants of a southward migration from polar Tertiary lands during Tertiary and even perhaps Cretaceous times, and in proportion to the high antiquity of the migrations there have been changes and extinctions causing the present anomalies in the distribution of organized beings, which are now so difficult to account for on any other hypothesis."

As Mr. Wallace could not in such a work enter into details of distribution beyond briefly describing his subregions, in which temperature and natural barriers need to be studied with care, he may have been led into the error of underestimating the influence of zones or temperature in determining the limits of distribution within the subregions. Much excellent work that has been done in this direction by American naturalists, who have had much better opportunities than European students, has been too hastily discussed either from want of space or from lack of information, since the great extent of North America as compared with that of Europe is exceedingly favorable to the formation of correct opinions regarding the influence of climate on species, an influence of greater

[1] Memoirs of the American Academy of Arts and Sciences. Boston. Vol. 6. See Sequoia and its History, American Naturalist, October, 1872, pp. 589, 590.

[2] On the Distribution of Californian Moths. By A. S. Packard, Jr. American Naturalist, August, 1873, and Proceedings of the Boston Society for May, 1873.



(Fig. 23.) THE NORTH AMERICAN PLAINS, WITH CHARACTERISTIC MAMMALIA.

importance in the origin of species than Darwinians as such seem willing to admit.

The errors of detail in the chapters we have read seem very few, and the wonder is that there should not be more. We notice that *Phrynosomæ*, or horned toads, are stated on one page to exist in New York and on another in Florida. We are not aware that the genus occurs east of the Mississippi River. *Siredon* is referred to the family *Proteidæ*, when it has been shown by Dumeril and Marsh to be simply a larval *Amblystoma*. An attractive feature of the work are the twenty full-page illustrations, showing the chief forms of land vertebrates characterizing the subregions. They are drawn with skill and evident fidelity, though the skunk on Plate XX. is not well sketched. Through the courtesy of the American publishers our readers can judge of the excellence of the plates by a glance at the two accompanying illustrations (Figs. 28 and 29). The colored hypsometrical maps add greatly to the value of the work. In that of North America the author colors yellow supposed desert tracts east of the Rocky Mountains, which farmers in Wyoming and Colorado would consider as reflecting on their possessions, and over which herds of buffalo a few years ago must have grazed with satisfaction.

In conclusion it may be said that while our author has shown that life has probably originated in northern lands, the question still remains to be answered, and the problem will probably not be solved for generations. What caused the radical differences in the life of the several continents? The united efforts of future palæontologists and biologists will be concentrated on this task, and centuries hence, if we mistake not, Alfred R. Wallace will be regarded as the pioneer in the work.

Recent Books and Pamphlets. — The Naturalist's Guide in collecting and preserving Objects of Natural History, with a Complete Catalogue of the Birds of Eastern Massachusetts. By C. J. Maynard. With Illustrations by E. L. Weeks. Salem: The Naturalists' Agency. 1877. 12mo, pp. 170. $2.00.

The Naturalist's Directory, containing the Names of Naturalists, Chemists, Physicists, and Meteorologists, arranged alphabetically, with an Index arranged according to Departments. By Samuel E. Cassino. Salem, Mass: The Naturalists' Agency. 1877. 8vo, pp. 20. Interleaved.

Materials towards a Knowledge of the Postembryonal Development of Insects. By Prof. M. Ganin. Warsaw. 1876. 4to, with plates.

Biologische Studien. Von Prof. Ernst Haeckel. Zweites Heft: Studien zur Gastræa-Theorie. Mit 14 tafeln. Jena. 1877. 8vo, pp. 99.

Beitrage zur Naturgeschichte der Daphnoiden. Von Prof. August Weismann. Parts II.–IV. Leipzig. 1877. 8vo, pp. 161.

On the Structure and Relations of the Alcyonarian *Heliopora cærulea*, with some Account of the Anatomy of a Species of Sarcophyton, Notes on the Structure of Species of the Genera Millepora, Pocillopora, and Stylaster, and Remarks on the Affinities of Certain Palæozoic Corals. By H. N. Mosely. (From the Philosophical Transactions of the Royal Society.) London. 1876. 4to, pp. 38.

Proceedings and Transactions of the Nova Scotian Institute of Natural Science of Halifax, Nova Scotia. IV. part 2. 1875–76. 8vo.

The Valorous Expedition. Reports by Dr. Gwyn Jeffreys and Dr. Carpenter. (From the Proceedings of the Royal Society, Vol. xxv. No. 173.) With chart and Sections. London. 1876. 8vo, pp. 60.

Check List of the Fishes of the Fresh Waters of North America. By David S. Jordan and Herbert E. Copeland. (From the Bulletin of the Buffalo Society of Natural Sciences.) 1877. 8vo, pp. 31.

The Fourth Annual Report of the Board of Directors of the Zoölogical Society of Philadelphia. 1876. 8vo, pp. 38.

Catalogue of the publications of the U. S. Geological and Geographical Survey of the Territories. F. V. Hayden, Geologist-in-Charge. Second Edition. (Revised to December 31, 1876.) Washington, D. C. 1877. 8vo, pp. 38.

Remarks on some Algæ found on the Water Supplies of the City of Boston. By W. G. Farlow. (Extracted from the Bulletin of the Bussey Institution. January, 1877.) 8vo, pp. 80.

Geological Survey of New Jersey. Annual Report of the State Geologist, for the year 1876. Trenton, New Jersey. 1876. 8vo, pp. 56.

New York Aquarium Journal and Guide. Illustrated. New York.

GENERAL NOTES.

BOTANY.[1]

On the Passage of Plasma through Living Unperforated Membranes, by M. Cornu. — The transfer of elaborated matters in cells presents many difficulties; in many cases osmosis alone is an inadequate explanation; it has been thought necessary to assume solution and recomposition of the substance, as in the case of starch. That the transfer of starch takes place in this way has been apparently admitted as the result of Mer's researches. Does plasma pass in the same way through the cell wall, having become first dissolved? Cornu thinks that it is transferred without solution, and bases his conclusion on his study of the germination of the spores of one of the Mucedineæ. In this case the plasma passes directly through the wall without rupturing it. The details of this most interesting observation are given in *Comptes Rendus*, January 15, 1877.

Phellodendron. — The list of exotic trees capable of withstanding the severities of the New England climate is not a long one, and any addition to it is a cause for congratulation, especially when, as in the case of *Phellodendron Amurense*,[2] the new-comer is extremely ornamental, and of rapid growth. Two plants of this *Phellodendron*, raised from seed in the Harvard Botanic Garden many years ago, are now some fifteen feet high, and have flowered the past summer for the first time; and as they have been fully exposed during ten or fifteen years, their hardiness in our climate would seem to be beyond doubt. The flowers of *Phellodendron* are diœcious, but by a piece of remarkable good fortune the two plants bore flowers of the two sexes, and an

[1] Conducted by Prof. G. L. Goodale.

[2] Rupurt and Maxim., Fl. Amus. t. 4.

abundant supply of seed has been secured. *Phellodendron Amurense* is a native of Manchuria, where, according to Maximonicz, it becomes a handsome, thick-leaved tree, fifty feet high, and with a trunk a foot in diameter. It occurs also in Japan, where a second species has been detected.

Phellodendron can be characterized by its corky bark; opposite, unequally pinnate leaves; oblong, lanceolate, acuminate, sharply serrate leaflets; small, green, diœcious flowers, borne at the extremity of the branches in loose corymbs; and by its five seeders, black, odoriferous, pea-shaped drupes, with flattened seeds, which in our species are two lines long, and covered with a shining black *testa*.

Its nearest North American allies are *Ptelea* and *Xanthoxylum*. — C. S. Sargent.

Modification of the Glumes of Grasses depending on the Sex of the Flowers. — Fournier gives as the result of his study of the grasses of Mexico the following statement: Among grasses with separated sexes, the female flowers differ very little, if at all, as regards the situation or form of the floral envelopes, when the sexes are borne on different plants; but when the plant is monœcious the glumes of the two sexes are widely different. These differences are most marked in certain genera of Chlorideæ, normally diœcious and accidentally monœcious. The grass described by Engelmann under the name *Buchlöe dactyloides* is a curious example in point. Beside this is now placed *Opizia stolonifera*, of which Presl had seen only the female plant. Although the female flowers of these plants differ very widely, their male plants resemble each other so much that they have been put in the same genus. *Casiostega humilis* is the male form of *Buchlöe*, and *C. anomala* is the male form of *Opizia*.

Living and Fossil Oaks of Europe compared by De Saporta. — Before the end of the Miocene, Europe possessed oaks which closely resembled *Quercus Cerris*. They had cupules of the same kind as the one now living, and the fruit matured in the second year. Three species in Auvergne belonged to the type of *Quercus Robur*, and "did not differ from the forms of this group more than these forms differ from one another." *Quercus pedunculata*, *sessiliflora*, and *pubescens* are relatively recent. In the middle of France, at least, these races have been preceded by other oaks, which have since partly disappeared and partly have been confined to a region farther south. On the other hand, species which now occupy only limited stations where they are threatened with extinction, like *Quercus Cerris* in France, appear to have had direct representatives there at an epoch relatively remote.

Absorption of Carbonic Acid by the Vegetable Cell Wall, by Professor Bohm, of Vienna. — Carbonic acid is atmospheric air, absorbed not only by the contents of green cells but by the cell walls themselves. Branches dried at 100° C. absorb more carbonic acid than

fresh twigs. But while in the latter the absorbed gas can be driven off tolerably rapidly by oxygen, hydrogen, or nitrogen, this happens in the first just as in the case of carbon, only more slowly."

Botanical Notes from Recent Periodicals. — *Flora.* Batalin, Mechanism of the Movements in Insect-Eating Plants (not yet finished). Dr. Celakovsky, On the Morphological Structure of *Vincetoxicum* and *Asclepias*. A. Poulsen, The Occurrence of Crystals surrounded by Cellulose (Rosanoff's crystals detected in the leaf stalks of many Leguminosæ).

Botanische Zeitung. 1877, No. 1. Dr. DeVries, On the Extension of Growing Vegetable Cells by Turgescence. V. Waldheim, A Fungus on Rumex. Nos. 2 and 3, Beyerinck, On Galls. No. 4, Jack, On European Hepaticæ. Continued in No. 5. Dingler, On *Lathræa rhodopea*.

ZOÖLOGY.

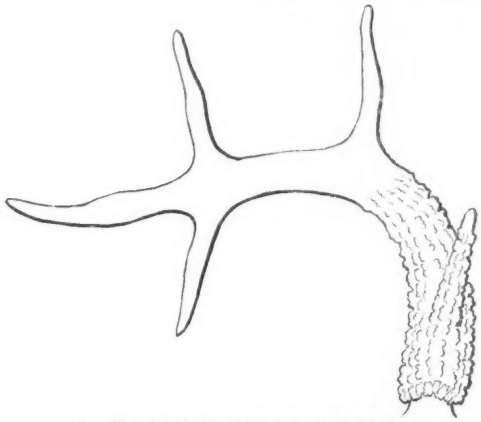
The Common Crab (Carcinus mœnas) at the Hawaiian Islands. — I desire to direct attention to the crustacean genus *Carcinus*, of which there is but a single species, *mœnas*. In 1873 the writer obtained a specimen from the Hawaiian Islands. This is the first well-authenticated instance, to his knowledge, where the species is recorded as coming from Pacific regions. In the Museum of the Academy of Natural Sciences of Philadelphia there is a specimen labeled from Australia, with an interrogation mark. It is found along the whole coast of Europe, from the Baltic to the Mediterranean; it is equally common and as widely distributed along our Atlantic coast. Heller reports having found the species on the eastern coast of South America, and it has likewise been obtained from the Red Sea; and now the Pacific Islands are added as a habitat. In the latter region, however, it cannot be very common, as it has eluded research up to the time mentioned, notwithstanding the fact that these islands have been pretty thoroughly ransacked for this kind of life. It may, however, be considered as cosmopolitan, as having a wider range than any other known species of crab.

What is particularly interesting in connection with its wide distribution is the identity of the species wherever found. Very slight differences can be observed in the specimens coming from these widely separated localities. The differences are not sufficient to constitute distinct species; at the most they would only form varieties. Carcinologists have agreed, however, to ignore the slight geographical variations and to designate them all by the same name.

The difference consists principally in the extent of the granulations on the surface of the carapace, and in the prominence of the front. Our Atlantic-coast crab differs from the European in having the surface more granular, and the teeth of the front somewhat more prominent; in the Pacific specimen the granulations are larger, and the front more projecting when compared with the former. It will be observed that

the changes increase in intensity as we travel westward. I do not know how these facts would hold through a large series of specimens; I have had an opportunity of comparison only with a limited number of specimens. The wide distribution of the crab, as is the case with all other forms of life similarly diffused, has had a tendency to preserve the species intact and to prevent a wide divergence from the primitive type. Those natural climatic laws which operate with the greatest intensity on those forms which are confined to restricted habitats are in this case inoperative. — Thos. H. Streets, M. D., U. S. N.

Note on the Deformed Antler of a Deer. — Dr. W. J. Hoffman, of Reading, Pa., sends me the accompanying figure and description of a malformation of the antler of a deer, probably a variety of *Cariacus Virginianus*. The specimen is said to have been obtained in California some years ago, and is now in the possession of a gunsmith in Reading.



(Fig. 30.) DEFORMED ANTLER OF A DEER.

The figure is taken from the right antler, viewed in position to occasion the least foreshortening of the supernumerary tine. It is drawn on a scale of one-tenth. The tips of the extra prongs are about twenty-six inches apart; distance between their bases, twenty-two inches. Although the various malformations of antlers are almost endless, yet each one has its own interest as an item in the history of the subject; and the facility of pictorial illustration of this class of objects renders extended description unnecessary. — Elliott Coues.

The Black Squirrel. — A female specimen of this species (*Sciurus niger*) of the exact color of the mink, the tail hairs light ochreish at the ends, was shot at Rodney, C. W., October 20th, by Mr. James Delaney, of Buffalo. The specimen is in the collection of the Buffalo Society of Natural Sciences, and it is remarkable for its extraordinary color, which is precisely that of the mink instead of the usual black of the species. — A. R. Grote.

The Raven and the Sooty Tern in Williamstown, Mass. — Some time since I secured here a fine specimen of the American raven (*Corvus carnivorus* Bartram), the first of its species, so far as I know, that has been captured in this region. Also last September I secured here a good specimen of the sooty tern (*Sterna fuliginosa* Gmelin) which, according to Lawrence, has its habitat in the latitude of Florida and Texas. It was killed near the Hoosac River. — Sanborn Tenney.

Partiality of White Butterflies for White Flowers. — On a September afternoon I observed in a field where a low white aster and a common golden-rod (Solidago) were abundant, twelve European cabbage butterflies (*Pieris rapæ*) fly directly to the less conspicuous but white aster, and invariably pass by the yellow flowers of the golden-rod. On a following day, however, the white cabbage butterflies on the same spot were seen occasionally to visit the golden-rod, but with an evident partiality for the white asters. On the other hand, the yellow sulphur butterfly (*Colias philodice*) visited the flowers of the golden-rod much oftener than those of the aster. — A. S. Packard, Jr.

The Phenomena of Digestion in the Cockroach. — In a late paper on this subject Prof. Felix Plateau concludes that the food after being swallowed accumulates in the crop, where it is acted upon by the salivary fluid, which is usually alkaline. There the starchy substances are transformed into glucose; this first product of digestion is here absorbed, and is not met with in the rest of the digestive canal. The valvular apparatus, which does not play the rôle of a triturating organ, allows small quantities of the matter in process of digestion to pass into the middle intestine of limited capacity.

This median intestine, or stomach, as it is usually called, receives the sugar secreted by light glandular cæca, the sugar being ordinarily alkaline, never acid, neutralizing the acidity as the contents of the crop gradually increase, transforming the albuminoids into bodies soluble and assimilable, analogous to peptones, and emulsionizing the fatty portions.

Finally, in the terminal part of the intestine are reunited the residues of the work of digestion, and the secretions of the Malpighian tubes, which are purely urinary in their nature. These researches complete and confirm throughout the results of Plateau's former investigations on the digestion of insects, published in 1874.

The Paper Argonaut captured at Long Branch, N. J. — Some little while ago a fisherman caught a strange object, and brought it on shore. It was the paper nautilus, the first time, probably, this animal has ever come so far north. Dr. Chattle made proposals to have it sent to Dr. Lockwood, which elicited a promise to that effect. But an enterprising genius got hold of the fisherman, and the nondescript was put in a tub of water and shown up at twenty-five cents a head. The animal was at last thrown away. — *Monmouth Democrat.*

The above occurred in August last, while I was out of the State. On

my return, to my great grief, I learned that the specimen had been wantonly lost. My informant in the matter is Dr. T. G. Chattle, of Long Branch, a gentleman of generous culture, and good observing ability. From his description I am satisfied it was an *Argonauta*, and very likely, though we may not be positive, the species was *A. gondola*. The animal was kept alive eight or nine days. Sometimes it displayed its arms in a feeble attempt to swim in its narrow confinement. Is not this the first instance of a capture so far north? Query, did this ancient mariner of the poets take it into its head to get into the Gulf Stream, and make us from its old-time seclusion, as some other folks have done, a centennial visit? — S. Lockwood.

A Flight of Butterflies. — About the first of October, while seated with a friend on the top of "Pegan Hill," an elevation of some four hundred feet, our attention was attracted to a continuous line of passing butterflies flying in a direct course towards the south, and at the height of thirty or forty feet above our heads. The day was warm and summer-like, with no wind to disturb the flight of the butterflies, which was remarkably steady and even, like the flight of migrating birds, and very unlike the usual zigzag movement of butterflies. We watched them for nearly an hour as they appeared in view from the north and moved steadily onward towards the south. Sometimes they appeared singly, sometimes in groups of three or four, but oftener in pairs, and flying six or eight feet apart. Being anxious to obtain a specimen, that the species might be determined, we made several vain attempts to bring one down by sending our walking-sticks after them. This put them in great confusion, entirely breaking up their line of march, and causing them to dodge rapidly to the right and left, and frequently to drop down several feet; although they continued on at the same rate of speed, they seemed unable to regain their former even flight, but kept up this zigzag motion till lost sight of in the distance. They were apparently one of our largest species, and were visible at least one eighth of a mile as they appeared in sight; it seems an important fact that they did not change their altitude in passing over the hill. We also noticed when descending the hill towards the north that they were flying at the same level till we were so far below them that they appeared but mere specks in the air above our heads, and before we had reached the plains below we had entirely lost sight of them. There was no reason to suppose that the butterflies changed their course in order to pass over this hill, or that the flight did not extend over the surrounding country. Having never seen any notice of the migration of butterflies or their movement *en masse*, it occurred to me that the phenomenon might happen annually, but at such a height as to pass unobserved. The butterflies were of large size and of a dark-brown color, but too distant to enable us to determine their markings. — Wm. Edwards, South Natick, Mass.

The preceding sketch, received from a correspondent, describes one

more instance of the rarely observed migrations of butterflies, and is printed in the hope of drawing forth accounts of similar observations. It is of course impossible to identify the butterfly seen by Mr. Edwards, but the swarming habits and lofty, sailing flight of *Danaida Plexippus* very naturally suggest this common insect. There are only two other common dark-colored butterflies which would be suspected of moving in such migratory swarms, *Vanessa cardui* and *Eugonia j-album*, and their flight would be different from that described by Mr. Edwards. Instances of the pseudo-migration of *Vanessa cardui* have been recorded in Europe,[1] and of a species of Eugonia (*E. Californica*) closely allied to *E. j-album*, in America (by Dr. Behr; Proc. Calif. Acad. Sciences, iii. 124). It has been suggested that these occasional movements among butterflies, which have been observed, especially in the tropics, in several genera of the larger forms, might be explained by a scarcity of the food-plant of the caterpillar, upon which the female lays its eggs; but this would scarcely be applicable to *Vanessa cardui*, since thistles and mallows — the food-plant of the larva — are abundant and wide-spread weeds. It would be well in observing such moving swarms to collect as large a number of butterflies as possible and determine the sex of each individual and the comparative maturity of the eggs.

It may be added, that when these observations of Mr. Edwards were read before a meeting of the Natural History Society of Boston, Mr. B. P. Mann stated that he once observed in Brazil a similar flight of a species of *Coea* or an allied genus. — Samuel H. Scudder.

ANTHROPOLOGY.

Anthropological News. — The most thorough and successful archæological work done on American soil in the last two years is that of Mr. Paul Schumacher in the Kjökkenmöddings and graves of the extinct races of the Santa Barbara Islands and the mainland. The islands examined were San Miguel, Santa Cruz, San Nicolas, Santa Barbara, and Santa Catalina. The mainland examined was the coast region of Santa Barbara and San Luis Obispo counties, most especially that portion in the vicinity of Point Sal. The Kjökkenmöddings are found wherever sandy ground exists. The deposits in these heaps are so much exposed to the driving winds that many of the objects of interest have been laid bare and carried off by casual visitors. The same winds which denude the shell heaps also expose the large whale's bones which were used by the former inhabitants to separate the bodies in the well-filled graves, and in this way serve as veritable tombstones to mark their sites. Mr. Schumacher opened several of these ancient sepulchres and took therefrom over a thousand skeletons, and with them many articles of ornament or use. The bodies were buried from three to six feet under ground, and sometimes from three to five deep; but it is evident from

[1] See American Naturalist, x. 610.

the disturbed condition of many skeletons that the burials were not all made at the same time. Most of these cemeteries are in the Kjökkenmöddings themselves, because the soil of these heaps is the only place which is not too hard for the aboriginal wooden spade, and is yet sufficiently firm to allow the digging of a pit. In connection with these digging sticks, Mr. Schumacher makes a very ingenious observation concerning the great quantities of stone rings, or "doughnuts," which are found here. From the testimony of an old vaquero he was led to believe them to have been designed to give weight to the spading stick. Among the many interesting objects of industry found, the mortars and pestles hold the first place. The fishing tackle comes next. Mr. Schumacher was so fortunate as to secure a full set of shell fish-hooks, and tools for making them, so as to illustrate the whole process. The shell ornaments and other burial deposits form a collection which must be seen in order to be appreciated.

Mr. Moses Strong, Assistant State Geologist of Wisconsin, has made a very extensive survey of the prehistoric mounds of Grant County in that State. These mounds are similar in all respects to those reported by Mr. I. A. Lapham in the seventh volume of the Smithsonian Contributions.

Quite a lively discussion has sprung up in the *Academy* for September 23d, et seq., around the assertion of Professor Mahaffy that cats were domestic animals among the Greeks, basing his belief upon the occurrence of the word γαλῆ in Aristophanes and other Greek writers. The question of the existence of domestic cats in Greece is discussed by Sir G. Cornwall Lewis (Notes and Queries, 1859, page 261). The subject is also treated by Professor Rolleston in a paper entitled, On the Domestic Cats, *Felis domesticus* and *Mustela Foina*, of Ancient and Modern Times, in the *Journal of Anatomy and Physiology*, November, 1867. The γαλέη, or γαλῆ, then, was one of the *Mustelidæ*, or martens, and the domestic cat was not known outside of Egypt before the Christian era. Mr. Mahaffy gracefully acknowledges the correction.

In the *Geographical Magazine* for October, Mr. E. G. Ravenstein publishes a series of maps of the part of Eastern Europe occupied by the Turks, showing (1) Political Divisions; (2) Density of the Population; (3) Mohammedans; (4) Nationalities. The author also reviews the history of that part of Europe overrun by the Turks.

Mr. A. H. Sayce reviews very favorably, with some slight criticisms, in *Academy* for October 14th, four very important works on Oriental Archæology: An Archaic Dictionary, W. R. Cooper (London: Baysted and Sons, 1876); Cory's Ancient Fragments. New and enlarged edition, E. R. Hodges (London: Reeves and Turner, 1876); Dates and Data relating to Religious Anthropology and Biblical Archæology (London: Trübner & Co., 1876); and Histoire ancienne des Peuples de l'Orient, 2nde Edition. Par G. Maspero (Paris: Hachette et Cie., 1876). The

first of these works is an attempt to do for Egypt and Assyria what Lemprière has done for Greece and Rome. The second work mentioned is an improved reprint of Cory's magnificent design of bringing together all the scraps of classical literature that bear upon the history and antiquity of the ancient East.

In the third work, the anonymous author "arranges in consecutive order, under specific dates, some of the results of recent researches on prehistorical and Biblical archæology and comparative mythology, with the view of attempting to furnish trustworthy materials for the study of religious anthropology." Of the last-mentioned work Mr. Sayce says, "The work is simply indispensable for all who wish to have some acquaintance with the subject."

In the *Contemporary Review* of April, Mr. Sayce discusses the jelly-fish theory of language. The principal feature in this theory is the belief that the sentence is the fundamental unit, and that words, especially "abstract and general terms, are only short-hand notes, in which we sum up the results of our analytical processes." — O. T. Mason.

GEOLOGY AND PALÆONTOLOGY.

The Trenton Limestone at Minneapolis. — The Trenton limestone in the vicinity of Minneapolis presents many features of interest both to the student of science and the simply commercial observer. The value which it possesses as the support of our magnificent water-power is sufficiently well known and appreciated. But to the student it is of interest on account of its accessibility and the varied forms of life which are preserved in it. Below are given a few notes upon some of the many fossils which have been broken from the massive escarpments that overlook the Mississippi below the fall. Two important divisions may be seen in the rock which are nearly equal in thickness. The upper being crystalline, the lower more firm, and better adapted for building purposes. Both are surmounted by a thin layer of shale of varying thickness. The total height of these in a vertical section is forty feet in round numbers, but it lies an equal distance above the river-bed, being supported by the St. Peter sandstone.

It is interesting to notice that the lower or building rock is not as devoid of fossils as has been somewhat generally supposed. There seems to be good reason to believe that life was at least as abundant at the period when these rocks were deposited as in the succeeding one. The reason the fossils in the lower rock have been overlooked is obvious on a careful study of the rocks. The upper is quite crystalline and the fossils preserved are almost entirely in the form of casts; these are loose and easily broken from the rock; they are also generally colored by iron, which is seldom the case in the lower layers.

Though it is true that they have been to a great extent destroyed, yet by a careful manipulation of the building rock many curious forms are

brought to light and they will be found much more perfect than those of the crystalline rock. In one locality *Cyrtolites compressus* (Con.) seems almost to form the basis of the stone. So abundant is it that a fragment could not be broken out without bringing to light some portion of a shell. *Chætetes lycoperdon* H. is also abundant, universally appearing on weathered surfaces in connection with *Escharopora recta* H., *Stictopora acuta* H., and other corals of a like nature, and crinoidal stems. *Chætetes* is detected in the body of the rock only by the diverging canals seen in a longitudinal section. The curious glabellæ of *Isotelus Iowensis*, or a related trilobite, is often seen in connection with fragmentary remains of other crustaceans. The textile markings of *Strophomena filotexta* H. and the rays upon the shell of *S. alternata* H. are well preserved, while in the upper layers only casts of a very imperfect kind were seen. Many other brachiopods are quite abundant, as *Rhynconella capax* Con., *Orthis testudinaria* Dal., *Strophomena deltoidea* H., etc. *Orthis subquadrata* H., is not uncommon, I think, in both layers. Lingulæ have been found throughout the series, *Lingula quadrata* and forms which may prove to be juvenal and distorted specimens of the same. Among gasteropods the Trenton limestone here is found to contain *Pleurotomaria lenticularis* H., *P. subconica* H., *P. subtilistriata* H., common to both divisions. With regard to the last, a specimen of this species which Professor Hall mentions as having been found only in the concretionary beds of Trenton at Watertown, N. Y., was found in the upper layers at Minneapolis, the size corresponding with that of the largest seen by Professor Hall. *Pleurotomaria umbilicata* H. is exceedingly abundant in the upper rock and a supposed cast of *Murchisonia gracilis* was broken from the same horizon as *Cyrtolites compressus*.

The shale on weathering leaves well-preserved shells and corals which appear almost as perfect as though collected from their native waters, particularly *Chætetes*, *Rhynconella*, and sections of crinoid stems in great variety.

Lamellibranchs are not wanting in all portions, the following having been noticed: *Edmondia subangulata* H. (one specimen). *E. subtruncata* H. (very abundant but quite variable in form. Casts alone have been found.) *Nucula levata* H., as well as several as yet not determined. — C. L. Herrick.

Whiteaves' Mesozoic Fossils of British Columbia. — The fossils described and figured in this report of Mr. J. F. Whiteaves, palæontologist to the Geological Survey of Canada, are mostly cephalopods, particularly *Ammonites* from the coal-bearing rocks of the Queen Charlotte Islands. The author states that "what little direct and positive evidence is at present afforded by the fossils from the Queen Charlotte Islands is in favor of their being referred to the Cretaceous period." Again he says more explicitly on page 91, "While, on the one hand, the fossils described in these pages show that the probable geological posi-

tion of the beds which contained them is near the base of the lower Cretaceous formation, or top of the upper Jurassic, they are insufficient to mark the definite horizon to which the series should be referred. It is sufficiently obvious that they exhibit a blending of the life of the Cretaceous period with that of the Jurassic."

Rominger's Fossil Corals of Michigan. — This is a treatise on the indigenous fossil corals of Michigan, forming the palæontology of the Reports on the Geology of the Lower Peninsula of Michigan. The value of the work is greatly enhanced by the large number of excellent photographic figures, printed by the Albertotype process. There are fifty-five plates, each usually containing four figures. A good many new species are described, and the work bears evidence of care in its preparation.

GEOGRAPHY AND EXPLORATION.

Geographical Progress in 1876.[1] — The geographical feature of the past year has been the increased interest shown in the enlargement of geographical knowledge, not only by the investigations and explorations which have taken place and the discoveries which have been made, but by the establishment of geographical societies in Denmark, Spain, and Portugal, by a large increase of members in the leading societies of England, France, and Italy, and in the inauguration by the king of Belgium of an international organization, composed of prominent geographers, African explorers, and the heads of the leading geographical societies of the world, to carry on the work of exploring and civilizing the interior of Africa upon a systematic plan, — a movement of great interest, and which in all probability will lead to very important results. The Challenger returned May 24, 1876, after an absence of nearly four years.

Archæological researches have during the past year been active and attended with interesting results. E. T. Wood, who spent eleven years in exploring the site of the City of Ephesus, contending with marauding brigands, and working in pits and trenches almost constantly under water, has during the year published the account of his labors. The German archæologists, Drs. Hirschfeld and Weil, and Mr. Bötticher, have been engaged during the year in making excavations at Olympia, in Greece, which, beside clearing the ruins of the temple and laying bare its marble pavement, have led to the discovery of numerous inscriptions, sculptures, and other objects of interest. The site of the celebrated temple, which for centuries was a dreary waste, has now, in consequence of these discoveries, become a resort for tourists. Mr. L. P. di Cesnola, who has been absent for three years continuing his researches in Cyprus, ended his labors last autumn, and is now upon his return to this city. He has discovered the site of Kurium, mentioned by Strabo, of which

[1] Abstract of Judge Daly's Address at the Annual Meeting of the American Geographical Society, New York, January 23, 1877.

no trace existed, identified the great temple of Apollo, and discovered the treasure chambers of another unknown temple, filled with innumerable votive offerings. He says that his last three years' excavations have surpassed those of the seven preceding years. Dr. Schliemann has followed up his excavations upon what he supposed to be the site of ancient Troy, by excavations upon the site of Mykenæ. Mykenæ is the most ancient city in Greece. It is identified with the poems of Homer, and Dr. Schliemann supposes that he has found the tombs of Agamemnon, Clytemnestra, and other Homeric personages. But whether he has or not, he has found and opened tombs which, from their cyclopean structure, belong to a very early period of Greek civilization. His excavations, which have been extensive, disclose the general topography of this very ancient and wealthy city, the monumental and other remains of which he carries back to 1200 B. C., the period to which the Homeric poems are usually ascribed.

In the United States the Coast Survey has made careful soundings in the Gulf of Mexico; the Hydrographic Bureau has assisted in correcting the charts of the West India Islands; the survey of the lakes has been carried on by the United States Engineer Corps; Colonel Ludlow's report of his reconnaissance from Carrol in Montana to the Yellowstone National Park has been published; the explorations of Lieutenant Wheeler west of the one hundredth meridian have been continued; Lieutenant Bergland has completed the examination of the Colorado River; Professor Hayden's explorations and other work have been carried on; Major Powell's expedition organized six field parties which surveyed much of Utah and Nevada. Under the direction of the Smithsonian Institution Judge J. G. Swan, of Portland, Oregon, has made a very interesting collection, illustrating the arts and industries of the Indian tribes, both of Western Oregon and Washington Territory. The Signal Service Corps, under the able direction of General Albert J. Meyer, is making rapid advances toward a complete knowledge of the conditions and causes of the American climate. It has nearly completed the most extensive collection of altitudes of places in North America which has ever been gathered. The list includes several thousand profiles, representing almost every railroad and canal. From this and other data it is making a relief model of North America on a large scale.

The Arctic event of the year has been the return of the English expedition, the Alert and the Discovery, under Sir George Nares, from the attempt to penetrate the Pole by the way of Smith's Sound. Regarded from a geographical and scientific point of view, the expedition was a success. I said in my annual address several years ago that to reach the Pole was not the main object in an Arctic expedition; that that was a mere geographical feat, to which necessarily great *éclat* would be attached; but that the real object of such an expedition was to explore the Arctic region in every direction, as far as possible, to obtain scientific in-

formation in a quarter of the globe where it was of the highest interest not only as respects the past physical history of the earth, but to enable us to unravel phenomena and obtain a knowledge of physical laws affecting its present condition which are of high scientific value, or, to express it in a popular form, of the greatest practical importance. This object has been to a considerable degree advanced by this English expedition. The Alert not only attained the highest latitude — 82° 24′ — ever reached by a vessel, and the sledge expedition, under Commander Markham, the furthest northern point reached by man, — 83° 20′ 26″ N. lat., but the expedition, in an unknown region, discovered and traced a line of coast extending over nearly fifty degrees of longitude, ascertained to a considerable extent the nature of the Polar Sea bordering this newly discovered coast, and collected a large amount of scientific information in the examination of both land and sea.

The rivers, coast, and interior of Western Africa have been explored by Beaumier, Tissot, Bonnat, Brazza, Marche, Duparquet, Lux, and others. The most important event in Africa of the year has been the circumnavigation of the Mwutan Nizige (Albert Nyanza), by M. P. Gessi, a member of Colonel Gordon's organization, who estimated the lake to be one hundred and forty miles in length by fifty in breadth. Its banks were clothed with a dense forest, the western side was mountainous, and the southern end shallow. This exploration establishes the connection between this lake and the Nile. From united statements of Gessi and Colonel Gordon, very recently received, it appears that the White Nile is navigable the whole way from Dufli to the lake, a distance of one hundred and sixty-four miles. About twenty miles south of Dufli the river widens, the current is less rapid, and from there to Magungo (on the lake) the river is nothing more than a part of the Mwutan Nizige. This river or expansion of the lake is broad, deep, and filled with islands of papyrus which make the banks difficult of approach. About one hundred miles from Dufli there is a large branch of the river extending north-northwest in the direction of the Nyam-Nyams.

Mr. Stanley, after exploring the west and southwestern shores of Lake Ukerewe (Victoria Nyanza), started from Dumo on its western shore and crossed the country of Unyora to the Mwutan Nizige (Albert Nyanza), and reached that lake at a point where a deep gulf (Beatrice Gulf), formed by a promontory colled Unsongora, runs out for thirty miles in a southwesterly direction. In his journey Stanley saw a mountain southeast of the Mwutan Nizige, which was reported to be from thirteen thousand to fifteen thousand feet high, called Gamboragarè, on the peak of which snow is frequently found. The exact position of this camp on the lake, as given by him, is 31° 24′ 30″ E. long., and 0° 25′ 6″ N. lat. Stanley, when last heard from in July, was on his way to Unamyembi, his intention being to proceed to Ujiji to explore Lake Tanganyka, and then endeavor to strike north toward the

Mwutan Nizige. An object of geographical interest at present is the great island of New Guinea, which, notwithstanding its magnitude, its fruitfulness, and position in the great ocean highway in which it is placed, was thirty years ago put down in the geographies as a *terra incognita*, or, as the geographer Murray expressed it, "viewed only by navigators at a distance." During the last five years it has been the scene of active explorations by Beccaria, D'Albertis, Moresby, Rosenberg, Maclay, the Russian explorer, Macleay, the English explorer, Macfarlane, Stone, and others.

MICROSCOPY.[1]

San Francisco Microscopical Society. — At the annual meeting of this society, held February 1st, the President, Prof. Wm. Ashburner, gave the usual annual address, in which he summed up with more than usual directness and precision the last year's progress and present standing of the society. The excellent financial condition was mentioned as a cause of increasing gratification and encouragement. The society comprises at present thirty resident, ten life, five honorary, and forty-one corresponding members; the resident membership being one less than last year, while the active membership, including resident, life, and those of the honorary members who reside in San Francisco, now aggregates forty-four, or three more than at the date of the last report. This very satisfactory condition has been attained without any effort to increase the membership. The only honorary member elected during the year was Mr. H. G. Hanks, one of the founders of the society and its president during the first three years. During the year twenty-three meetings were held without one failure for want of a quorum, with an average attendance of between eleven and twelve, or the same as the previous year, while the attendance of visitors was less than before. At the annual reception nineteen members participated and two hundred and eighty visitors were in attendance. The exhibition was notably successful, but the effort to present a somewhat orderly arrangement of objects representing in a proper series the different kingdoms of nature was, owing to want of time for maturing the plan, less fully satisfactory than it is expected to be in future after further labor and study. The library contains two hundred and thirty-seven volumes, an increase of one hundred and three over last year. The cabinet now contains five hundred and twenty-three slides, an increase of ninety-four, the set of animal parasites being especially full and numbering seventy slides. Some interesting apparatus has been acquired by purchase and donation; and the occupation of new and pleasant rooms has made the past year conspicuous in the history of the society. Alluding to the previously reported failure to attain a fully satisfactory result in the way of resolving difficult diatoms, and especially the last

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

three numbers of the Möller Probe Platte, with the new Tolles objectives, the president states that further experience, and intercourse with experts in this special branch of work, has rendered such resolution so simple and easy as to cause wonder how it ever appeared difficult; and he adds the following very interesting remarks on apparatus and test objects: —

"In justice to Mr. Tolles it should be stated that the fault did not lie with the objective, but rather in our own inexperience, for, in proper hands, by its means, the No. 20, or *Amphipleura pellucida* was immediately resolved, after having procured the finest definition of the two preceding ones. While what I now say relates particularly to the $\frac{1}{10}$th, which has accomplished most satisfactorily all that was claimed for it, I cannot pass over in silence our new $\frac{1}{6}$th immersion, by the same maker. With this objective I have by lamp light frequently resolved the last three diatoms on our balsam plate, which has been pronounced a more than ordinarily difficult one, with an ease and clearness of definition that is wonderful, and far surpasses anything I have before had an opportunity of witnessing. Not only does this glass possess in a superior degree the qualities heretofore claimed only for those having the highest angular aperture, but such is its ample working distance and great penetration, that it answers admirably for investigations upon animal and vegetable tissues, where those attributes are so necessary.

"In speaking as I do with regard to resolving difficult diatoms, I would not have you think that I attach more importance to this matter than it really deserves, nor would I for a moment propose it as an end for anything more than to exercise the student in the manipulation of the microscope. In fact, as problems in mathematics teach the use of figures and quantities while they improve the mental faculties, so this resolution of diatoms, which has been so much decried as being a sad waste of time and energy, gives to the manipulator a skill in the use of his instrument without which no success can be obtained. If our effort were to end after having resolved a few diatoms, I should say our society was anything but a success, and although it might have afforded entertainment to its members for the last five years, it had failed to produce any good or lasting effect. To know how to use the microscope with skill is one thing, but to know what you see with it is another and a far more difficult subject; but it is also one which we have by no means completely neglected. That we have a realizing sense of the importance of this branch, and that our progress has not been entirely in the way of material prosperity, I would present as an evidence the recent formation of a class in microscopy, under the instruction of our librarian, Mr. X. Y. Clark, which, I consider would have been an impossibility a few years ago, when so many of our members were interested in the microscope as a novelty, and, perhaps, without speaking offensively, more as a toy than as an instrument with which to acquire real knowledge and instruction."

Laboratory Work in Microscopy. — Two of the summer courses of instruction in science at Harvard University, this summer, will include laboratory work with the microscope, and special instruction in its use in botanical study, the preparation and preservation of objects, etc. No higher guarantee of the excellence of this instruction can be given than is implied in the fact that the course on Phænogamic Botany is to be given by Prof Geo. L. Goodale, and that on Cryptogamic Botany by Prof. W. G. Farlow. Each course is of six weeks' extent, and is open to applicants, at a fee of $25.

Printed Labels. — Mr. F. F. Stanley of 40 Pearl Street, Boston, Mass., having made arrangements for the printing of his labels of proper size and style for the usual 3x1 slides, will supply the labels for the accommodation of any microscopist, at the cost of twenty-five cents per one hundred labels of any desired subjects. Labels to match, giving name of preparer, can be furnished at the same price in quantities of not less than one hundred of a kind.

Second-Hand Microscopes. — Any microscopist desirous of obtaining a first-class Zentmayer binocular or a Beck Popular binocular, at a very low price, can hear of an opportunity by addressing the Editor of this Department.

SCIENTIFIC NEWS.

— The Harvard Natural History Society, an association of teachers and students at Harvard University, has offered prizes for essays on subjects connected with the natural sciences, by pupils in high schools, or schools of that grade, public or private. The first prize will be a sum of $25.00 and a collection of geological specimens and models. The second prize will be a sum of $20.00 and a collection of insects. For farther information apply to the secretary, George Dimmock, Cambridge, Mass.

— We have received a Preliminary Announcement of a Scientific Expedition around the World, organized on rather an unique plan, to be conducted by a faculty of ten. There will be accommodations for sixty to eighty students. For farther information we would refer our readers to James O. Woodruff, Indianapolis, Ind., or Prof. W. L. B. Jenney, Chicago, Ill., or Prof. J. B. Steere, Ann Arbor, Mich.

— At its last session Congress made an appropriation of $18,000 for a commission of three skilled entomologists to investigate and report on the ravages of the Rocky Mountain locust and to suggest means for their prevention; to be appointed by the Secretary of the Interior. The commissioners have been appointed, and the board organized under the name of the United States Entomological Commission, with C. V. Riley president, A. S. Packard, Jr., secretary, and Cyrus Thomas treasurer.

PROCEEDINGS OF SOCIETIES.

Iowa Academy of Sciences. — October 6th. Professor Bessey read a paper on Some Observations upon the Growth of Plants, made by Means of Arc-Indicators. Professor Macomber read a paper on The Barometer as an Indicator of the Weather. A List of the *Odonata* of Central Iowa, prepared by Herbert Osborne, was communicated by the chairman.

Professor Bessey read a paper entitled A Case of Selection, pointing out how the relative number of individual plants of blue-grass (*Poa pratensis*), white clover (*Trifolium repens*), and *Panicum glabrum* changed under certain conditions, the first decreasing and the last two increasing under more frequent close cutting.

Also, by the same, Observations on *Silphium laciniatum*, the so-called compass plant. About thirty per cent. of all the leaves of this plant do not deviate more than five degrees from due north; forty-two per cent. deviate less than ten degrees, and ninety per cent. deviate less than forty-five degrees, so that it fully deserves the common name of compass plant.

Academy of Natural Sciences, Philadelphia. — December 12th. Professor Cope exhibited a jaw-bone of a Dinosaurian reptile of the genus *Lælaps*, from the Judith River beds, and described its characters. It was said to be the most perfect specimen of the kind yet found, although the whole jaw was at least a foot longer than the specimen. He added three species of *Lælaps* to those already described from the Judith River beds, making six in all from that locality. Ten species of herbivorous dinosaurs have been described from the same formation. He at first thought the specimen exhibited might be the *Aublysodon horridus* of Leidy, but the anterior teeth differ materially from those of the species named. The name *Lælaps incrassatus* had been proposed by Professor Cope for the form some time since, on the evidence of a few teeth.

A number of specimens of teeth of the other species of *Lælaps* and *Aublysodon* were shown and described. The *Lælaps incrassatus* is the largest species as yet found in the Western beds. A new genus, which was stated to be between the genera *Paronychodon* and *Lælaps*, was described under the name *Zapsilus*.

Professor Cope also exhibited a cast of the interior of the cranium of *Oxyæna forcipita*. The anatomical peculiarities of the *Creodonta* were dwelt upon in this connection. The form of the brain resembled most nearly that of the opossum.

December 19th. Professor Cope exhibited a specimen of the cranium and some other bones of a fossil reptile of the genus *Clidastes*, in a single slab of the Cretaceous chalk which composes Cretaceous number three of the West. The specimen consists, in addition to the cranium, of the atlas and two of the cervical vertebræ, the former exhibiting the four elements of which it is composed.

New York Academy of Sciences. — February 5th. Mr. Henry S. Munroe remarked on prehistoric bronze or copper bells, lately exhumed in Japan, and exhibited specimens.

Boston Society of Natural History. — February 7th. Prof. W. G. Farlow made some remarks on cedar apples (*Gymnosporangium*) and *Ræstelia*.

SCIENTIFIC SERIALS.[1]

Monthly Microscopical Journal. — February. On the Relation between the Development, Reproduction, and Markings of the Diatomaceæ, by G. C. Wallich. Observations on Professor Abbé's Experiments illustrating his Theory of Microscopic Vision, by J. W. Stevenson.

The Geographical Magazine. — February. The South African Republics, by E. G. Ravenstein (with a map). The Abbé Armand David's Travels in China, by A. E. Hippisley. The North Siberian Expeditions. The Temperature of the Atlantic Ocean, by J. E. Davis. The Age of this Earth, by H. P. Malet.

The Geological Magazine.— February. On Two New Palæozoic Crustaceans from Nova Scotia (*Anthrapalæmon Hilliana* and *Homalonotus Dawsoni* Hall), by J. W. Dawson. A Question for Silurian Geologists, by J. R. Dakyns. Considerations on the Flotation of Icebergs, by J. Milne. Notes on Coral-Reefs, by H. Hoskyns. High Level Terraces in Norway, by J. R. Dakyns.

Annals and Magazine of Natural History. — February. List of the Species of Crustacea collected by the Rev. A. E. Eaton at Spitzbergen in the Summer of 1873, with their Localities and Notes, by E. J. Miers. On the Fundamental Error of constituting Gromia the Type of Foraminiferal Structure, by G. C. Wallich.

Annales des Sciences Naturelles. — December 15, 1876. Recherches sur l'Appareil Respiratoire et le Mode de Respiration de Certains Crustacés Brachyures (Crabes Terrestres), par G. Duchamp. Mémoire sur les Métamorphoses des Acariens en général, et en particulier sur celle des Trombidions, par P. Mégnin. Note sur les Oiseaux de la Nouvelle Zemble, par M. Theel. Recherches Expérimentales sur les Functions de la Vessie Natatoire, par A. Moreau. Histoire des Clausilies de France Vivantes et Fossiles, par J. R. Bourguignat.

Bulletin of the American Geographical Society, New York. — No. 2. Addresses by Col. T. B. Myers and Rev. Dr. Bellows at the opening of the Society's building, November 28 and 29, 1876. Spitzbergen Seas and a Boat Journey in Lapland, by A. H. van der Horck. The Republics of South Africa, by Miss Russell. Philosophy of the North American Indians, by J. W. Powell. No. 3. Address of Chief Justice Daly on Geographical Progress in 1876.

[1] The articles enumerated under this head will be for the most part selected.